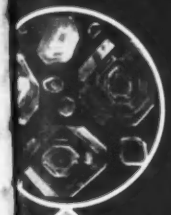
Read Chemicals Raise Crops

CHEMISTRY



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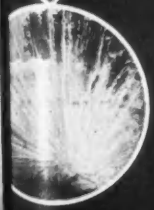

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A SCIENCE SERVICE PUBLICATION

Secret Information

▶ SECRECY is the very antithesis of the method of science, and the Atomic Energy Commission is to be commended on its release of some of the data essential to the construction of low power nuclear reactors for research purposes. The probable effect of this information on the non-scientific world is, we think, well shown on page 10 of this issue.

The results of harnessing atomic energy can be foreseen but a little way today. The immediate outlook is grim, as we wait to see whether and where the atomic bombs will fall. Well meaning citizens organize first-aid courses in happy ignorance of the degree of devastation atomic holocausts can wreak, and the overwhelming chances against survival of individuals in target areas. Detergents are touted as "decontaminants," though it is obvious that all that can be done is to move radioactive material from one place to another for the remainder of its life.

Some progress has been made toward solving some of the enormous problems of power reactors. It is a sad, but not necessarily hopeless, sign that the immediate goal of these researches is more compact power plants for submarines. The Greeks, it will be remembered, ascribed all the misfortunes of the world to the discovery of iron. Yet iron today finds constructive uses, even though we did bring our richest iron-ore deposits nearly to depletion in 1940-45. Reactions still undreamed-of will probably make unequal distribution of natural resources inconsequential. This should make for a more peaceful world for our peaceful descendants or their alien successors.

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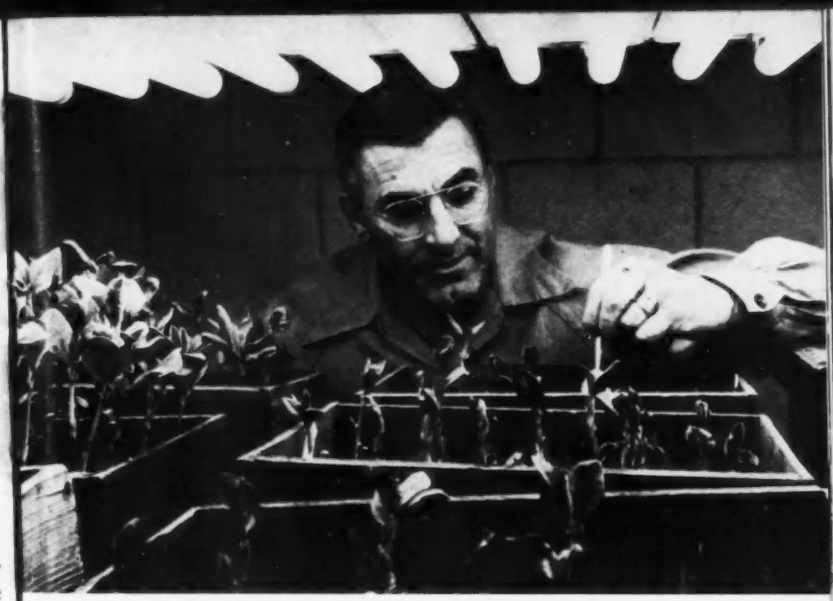

THE CROPS OF *plant lice being raised on these plants, warmed by 16 hours of artificial sunshine a day, are being carefully tended by Dr. L. C. Glover, entomologist, who will soon turn about and subject them to chemical warfare in the form of sprays and other poisons.*

Chemicals Help Raise Crops

ONLY A VERY POOR farmer does not use a variety of chemicals to help him raise his crops these days. Gasoline, kerosene and lubricating oil have substituted for corn, oats and hay as the energy source for power down on the farm. Chemicals kill the "bugs," control the weeds, fertilize the crops, fumigate the soil, regulate the ripening of fruit, create artificial frost to hasten harvest, and preserve the harvest when it is obtained. Many of these agricultural chemicals are made from the crude petroleum that also fuels the farm tractors that have put the horse out of his job.

Much of the scientific revolution that is occurring in agriculture is due to the development of new materials to do things on the farm that could not be done before. This is translated into more crops per acre, more dollars of profit for the farmer, and more food available for the more people that we have in the world.

Agricultural research has been historically the concern primarily of the federal and state governments with

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their agricultural experiment stations connected with state colleges and universities. Out of these developments paid for by public funds have come bonanzas of benefit to the nation's farmers. Industry has been less interested in agricultural research than in research laboratories that made scientific inquiries seemingly more directly related to manufacturing and city living.

In California's rich San Joaquin valley there is an unusual 142-acre farm that is an agricultural laboratory run by one of America's large industrial organizations, the Shell Oil Company. Not an oil tank is to be seen and the usual apparatus of a refinery is lacking, yet petroleum chemicals, as many as 1300 different ones, have come to grips there with all the kinds of farm pests and plant diseases that are encouraged and pampered there for the sake of science and better farming.

Along with the more down-to-earth practical tests of new insecticides, weed killers, sprays and fertilizers, a staff of scientists any college would be proud to have are engaged in fundamental problems related to plant growth in its broadest aspects.

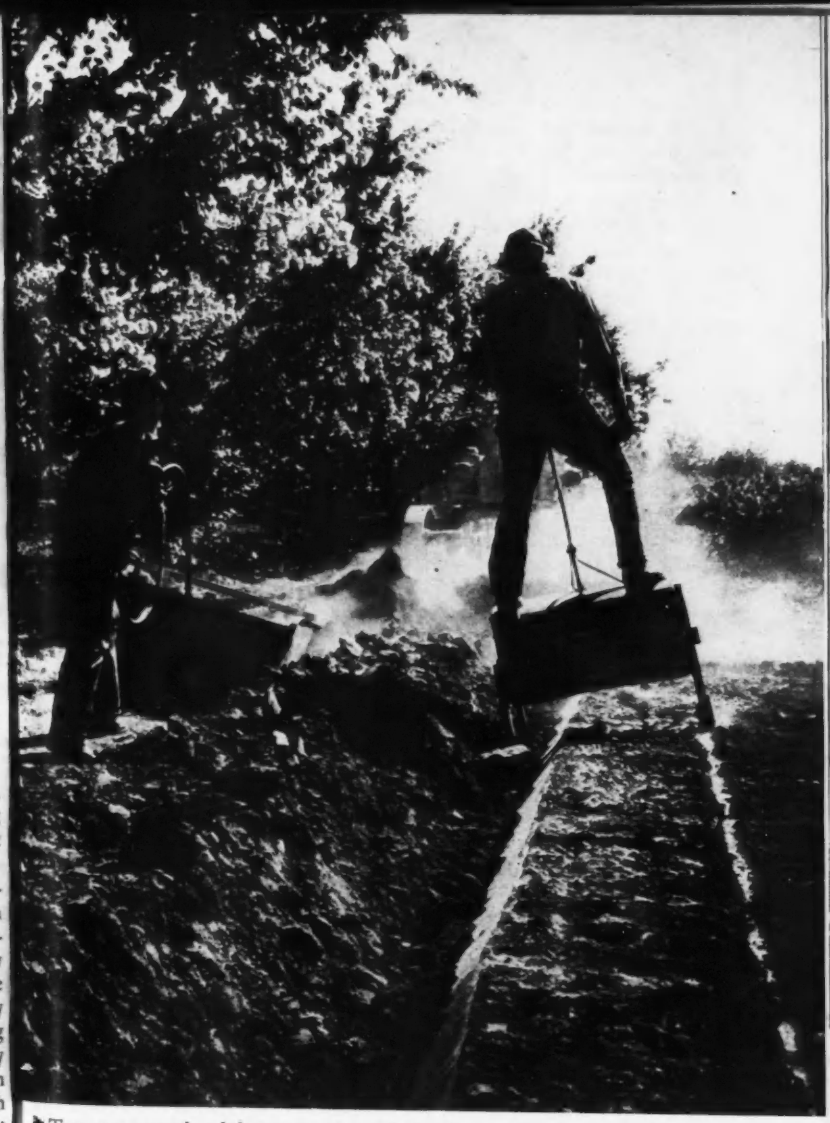
Producing technological unemployment among tiny wasps may not be the most important thing that has been done at Shell's agricultural laboratory-farm, but one result is that there are being marketed this year for the first time seedless figs. The Calimyrna fig is a crop that is worth millions of dollars each year. But to have the fruit set right, a special kind of wasp is needed to do the pollinating. Growers have had to put out cultures of wasps so that each fig would receive the proper attention.

As a consequence of the discovery of growth-regulating hormones, Dr. Rene Blondeau, then Shell's plant physiologist, and Dr. Julian C. Crane of the University of California's station at Davis, worked out a commercially feasible method of using a synthetic hormone spray that makes the wasps no longer necessary. The chemical used is 2,4,5-trichlorophenoxyacetic acid. The spray substitutes for the pollen so effectively that the fruits formed are comparable in size and color to mature, pollinated fruits. And they are ripe in half the time needed for the normal fruit development, 60 days instead of the average 120-day period. This is not of as much consequence as it would be if figs were not sold as dried fruits. The time of marketing is not as important as in the case of fresh fruits.

The hormone-produced figs are completely devoid of the "seeds" (achenes). This gives a new sensation to fig eating, without seeds stickin one's teeth. The crunch of biting into an ordinary fig is lacking, which some people may not relish.

Other synthetic hormones are in use to prevent apples from dropping off the trees before the orchardist wants to harvest them.

Still other chemicals are now widely used to strip the leaves off cotton plants before mechanical cotton pickers are used to harvest the snowy bolls. If the leaves are still on the plants when cotton is mechanically picked, they stain the cotton, making it dirty and lowering its grade. Early cotton defoliants were applied in powders, which worked in the South because of the heavy dew there, but Shell had to work out an oil soluble



▶ THE OUTDOORS *is a laboratory, too, and plowing, cultivating, and spraying are done on carefully controlled schedules at the Shell experimental farm.*

cotton defoliant for use in other areas.

Similar methods of removing leaves before harvesting, known as "artificial frosts" are applied to other crops, such as soy beans, in the midwest.

The same general kind of chemicals can be used to kill weeds, defoliate, promote root growth on cuttings, substitute for pollination, and even in the case of total war, wipe out the food crops of the enemy, as the United States was prepared to do in the case of the Japanese rice crop if it had become necessary in World War II. It is a matter of concentration, slight changes in chemical composition and the time of application.

Oil alone, which is a sufficiently complex chemical in itself, can in many cases kill plants and be used to control plant growth. One part of the plant physiology research conducted by Dr. J. van Overbeek of the Shell Agricultural Laboratory is devoted to fundamental work on how plants are killed. There may be direct penetration through the cuticle of the leaves or through their stomata allowing the cells within to be attacked. Or there may be an indirect effect on cells through blocking the transport of water to them, or a direct effect on the cells through poisoning them acutely or chronically.

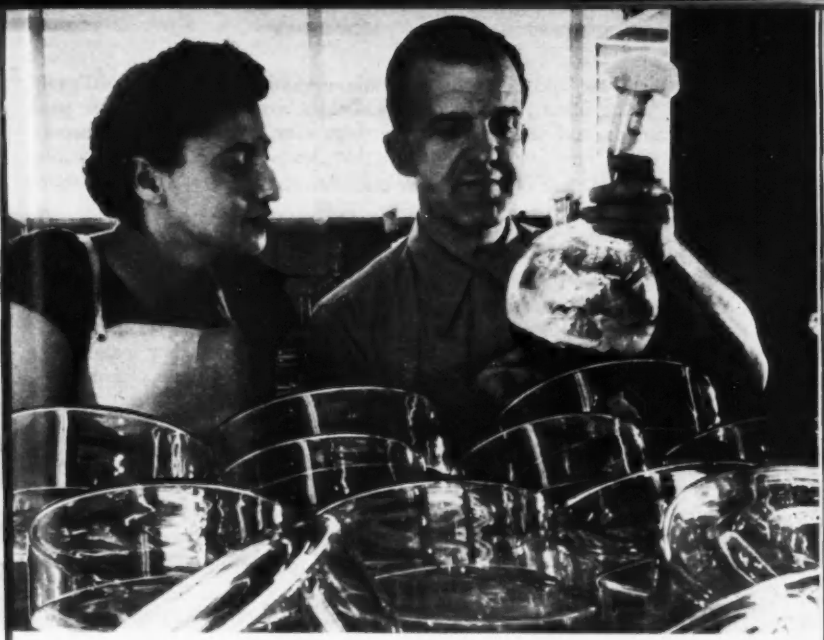
The route of air into the leaves, the stomata, is not open to water because of surface tension, but kerosene does go into the stomata, damaging the cells in the plant.

These stomata open each morning and close each night, being ready for business when the sunshine furnishes energy for food manufacture in the plant cells. This suggested the possibility of using a light petroleum oil alone or as a spray vehicle carrying insecticides and other chemicals with more effect than water or as dust. The trick would be to spray at night when the stomata are closed.

Dr. Overbeek tried an oily spray and it worked out. At night, bean plants were undamaged by a spray that they could not stand by day. Unwanted grass among the beans was killed both day and night. Whether this will lead to practical oil spraying in the dark for weed control is for the future to tell. One disadvantage is that the volatile oil that must be used is flammable.

Fine mist spraying of emulsions promises to take the place of larger volume water sprayings. In part this is due to better emulsifing agents, and in part to the development of apparatus for creating and applying the mist that covers more area with less volume sprayed. Ten gallons of mist may do what 150 to 200 gallons of water solution has done.

Fumigating and disinfecting the soil is paying big returns, often tripling the yield of such crops as onions which are affected by nematodes, that knot up and damage the portion of the plant beneath the ground. Nematodes are one of the greatest of all agricultural pests, ranking with insects in their damage. They are very small creatures, between 1/25 and 1/65 of an inch in length. If the soil is treated with a poisonous chemical before the crop is planted, the nematodes and other soil pests can be destroyed. In 1942 the work of Dr. Walter Carter of the Pineapple Research Institute of Hawaii demonstrated that a dark-colored, liquid mixture of unsaturated chlorinated compounds,



➤ FUNGI ARE *dangerous pests of crops. Dr. W. A. Krentzer is holding a flask of a mass culture of fungi that are about to become victims of new kinds of fungicides that are being tested.*

dichloropropane, dichloropropylene, called D-D, was effective in controlling nemotodes, wireworms and other soil pests. It is stuck into the ground a few weeks before planting, the underground pests are killed and the poisonous chemical seeps away before damage can be done to the crop.

Other soil fumigating chemicals that promise to be twice as effective as the pioneering D-D compounds are forecast by research at the Shell laboratory.

Dual purpose chemicals, that kill the fungi that wilt and otherwise damage plants as they also kill the nematodes, are also being developed.

Farmers may not realize it completely but the hazards of agriculture are so great that Dr. Roy Hansberry, director of the Shell Agricultural Laboratory puts it: "We doubt if there are really any healthy plants in nature." He is an entomologist, but he and his staff of scientists realize that the insects are only one of the many plant enemies against which farmers must wage chemical warfare. Insects are usually more easily seen and they have thus received major attention in the past.

On this strange farm in California with its laboratories and green

houses, there are special rooms devoted to raising insects, such as cockroaches, aphids, and various kinds of flies on which new insecticides can be tried. There are 35,000 to 40,000 little flower pots, each containing a standardized tomato or some other plant, which can be used as medical laboratories use experimental animals.

In the fields there may often be seen a strange apparatus injecting ammonia into the soil, for that is a widely practiced method of applying nitrogen for fertilizer. Or the ammonia may be added to the water in the irrigation ditches, so that moisture and food arrive at the plant at the same time. In the same irrigation ditch or a nearby experimental pond, there may also be added a chemical that keeps it free from unwanted plants, or weeds that clog the waterways.

Quite frankly, one of the world's great oil companies conducts this kind of research operation because the farms, orchards and fields of America are a growing market for the old and new chemicals that they manufacture from petroleum. These chemicals increase the yield of the soil as they bring industry and agriculture into greater dependency and mutual usefulness.

On The Back Cover

➤ IN A HOUSE *made of laths that protect tender foliage from the hot, dry winds of California's rich central valley, these carefully raised plants are being produced in order to use them for testing petroleum chemicals—what effect they have on the plants themselves, or the pests that prey upon them. Photos by Con Gebbie.*

Nylon Base for Metal Tubes

➤ A NEW USE for nylon, unrelated to stockings or other familiar articles, is reported from Sweden's Research Institute of National Defense. Drawn nylon fibers can be used as a base upon which to deposit electrolytically very fine metal tubes useful in electronics and instruments.

Other materials have been used in this way, but they have been very hard to remove from the inside of the tube, particularly when the walls are thin and of small diameter.

The method of making the small metal tubes was communicated by Dr. Rolf J. E. Gezelius, a Swedish scientist, to the *Review of Scientific Instruments.*

New Uses For Strange Elements
New Processes For Familiar Ones

Vital Defense Metals

➤ ZIRCONIUM, a metal that is most familiarly known in mixtures for the semi-precious gem stones, zircons, is being used in building our newest atomic "furnaces."

The Atomic Energy Commission would like to get this metal in ton lots for building atomic "ovens," but present production is only about 1,200 pounds per week. Even this is a big improvement, both in quantity and purity of the metal, over production before the metal had proved its worth as a structural material for atomic furnaces.

Only recently have methods for producing this metal in quantity been perfected. Melted zirconium, like titanium, its closest chemical relative, either reacts with or dissolves many of the usual materials used for melting vessels. Thus to separate it in pure form from the other ores with which it is found required great ingenuity for which American engineers can take credit.

The U. S. Bureau of Mines obtains the metal by reducing zirconium chloride with molten magnesium. Highly resistant to many acids and with a melting point above 3400 degrees Fahrenheit, the metal would seem a natural for atomic pile use, but was not taken seriously because of the difficulty of handling it, separating it in a pure form.

Materials used in atomic furnaces cannot have any special liking for the neutrons that keep the chain reaction going. Steel, for instance, sops up neutrons although it is otherwise a good structural material. Zirconium, however, has a "low neutron capture cross section," as the liking for neutrons is called by the physicists, and it, or an alloy of it, is therefore being used for building atomic furnaces.

The first sizable production of zirconium has started in a new mill at the Northwest Electro Development Laboratory of the Bureau of Mines at Albany, Ore. Zirconium has previously been used in small quantities in flashlight bulbs, and radio tubes as well as in some alloys of steel and copper.

Although the metal is well distributed in the earth's crust, the U. S. is dependent upon foreign supply, principally Australia, for most of its zirconium ore and concentrates. How much we are adding to our stockpile of war strategic materials is classified information.

In powder form, zirconium is black, looking much like charcoal dust. When melted, the metal is steel-gray. It can be polished to make a lustrous metallic mirror.

When AEC demands for this metal are satisfied, industry will get a chance at it, taking advantage not only of its corrosion-resistant properties, but also of its alloying qualities.

Better Beryllium

➤ BETTER BERYLLIUM metal parts in the nuclear reactors used in atomic energy work is promised as a result of investigations in powder metallurgy which indicate that a more ductile beryllium can be formed by this process.

The importance of beryllium in atomic energy work is due to its mechanical, chemical and other properties, particularly its low neutron capture properties. Beryllium metal has low density, good resistance to corrosion and high relative strength.

Investigations of beryllium articles made by the powder metallurgy method was described to the American Society for Metals by Dr. H. H. Hausner and N. P. Pinto, both of Sylvania Electric Products, Inc., Bayside, Long Island, N.Y.

Beryllium pieces produced by usual casting and extrusion methods appear to lack ductility at room-temperatures. Beryllium powders can be compacted into solid pieces at room temperature without difficulty, these scientists found. No binder is needed.

In order to obtain a material of fairly high density, the beryllium compacts may be heat-treated, or sintered, in a high vacuum or in a protective atmosphere such as argon. The process is carried out at temperatures below the melting point of the metal.

Vacuum-sintered beryllium has measurable ductility. Argon-sintered beryllium compacts are brittle. Vacuum-sintered beryllium can be reduced 9% in thickness by cold-rolling, followed by annealing, which gives an improved product.

What Makes Steel Hard

➤ EXTREME COLD has been the key to a new understanding of what makes steel really hard, Dr. James R. Killian, Jr., president of the Massachusetts Institute of Technology, has stated.

Recent studies at M.I.T. have gone a long way toward a solution of the age-old problem of how steel hardens, he said. The same research has cast uncertainty on many low temperature theories by showing the possible role of extreme cold in the hardening of steel.

Dr. Killian was discussing cold in the region near absolute zero, which is approximately 460 degrees below zero on the Fahrenheit scale. The recent studies at M.I.T. show that the atoms in steel can rearrange themselves in the process which makes steel hard even at the extremely low temperatures of liquid helium, 453 degrees below zero.

This discovery, he declared, refutes the idea that the mobility of atoms decreases as their temperature goes lower and lower. This implies that all atomic movements cease at extremely low temperatures and that no changes such as the hardening of steel may occur.

Instead, it appears that steel hardening takes place more completely at low temperatures than at any others. The new studies indicate that steel hardening is a cooperative shear-like "sliding" in which atoms move in unison. At extremely low temperatures large groups of atoms in steel appear to participate in this sliding motion, and thus are transformed from a soft form known as "austen-

ite" to a hard form known to metallurgists as "martensite."

Use For Cobalt in Alloy

➤ DEFENSE NEEDS for cobalt, a silver-white metal which can withstand the hell's fire of jet and gas turbine engines, will be felt first by makers of television and radio sets.

A cut of 70% was made by the National Production Authority in November deliveries of cobalt for non-defense purposes. Chief among civilian uses of cobalt are special alloy steels used in making permanent magnets in television, radio and telephone receivers.

For a one-week period cobalt was frozen completely by government order. A spokesman for the Radio-Television Manufacturers Association said that without any cobalt at all, the industry would have had to shut down completely by the end of the year.

Cobalt alloy magnets are used in the electrical generators of airplane and tank engines. Mixed with beryllium and copper, cobalt goes into the propeller hubs of piston-driven aircraft.

But the most vital use of this highly-strategic metal is in alloys. Mixed with chromium and tungsten, it makes a material called stellite. Stellite is the stuff of high-speed, heavy-duty, high-temperature cutting tools which are harder than any steel at red-hot temperatures.

Special steel alloys are made containing cobalt. These steels have wide uses in munitions and defense equipment.

Vitallium, an alloy containing about 65% cobalt, 30% chormium and 5% molybdenum, is used as a heat-resistant material in gas turbines and jet engines. (It is also used by dentists and doctors as a non-corrosive, electrically neutral metal for teeth fillings and surgical needs.)

Cobalt compounds are vital in making enamels stick to metal. They are used as pigments in paint, to color glass, in livestock feeds and in nickel-plating.

The major source of cobalt in the world is the Belgian Congo. A single company, the African Metals Corp. of New York, is the only cobalt importer. In this country, only an insignificant amount is produced, although the United States is far and away the world's biggest user of cobalt.

Ni-Al-Mo Alloys

➤ ALLOYS containing nickel, aluminum and molybdenum give promise of satisfaction in the blades of gas turbines in airplanes and other applications, the American Society for Metals was told by Canadian scientists at a recent meeting in Chicago.

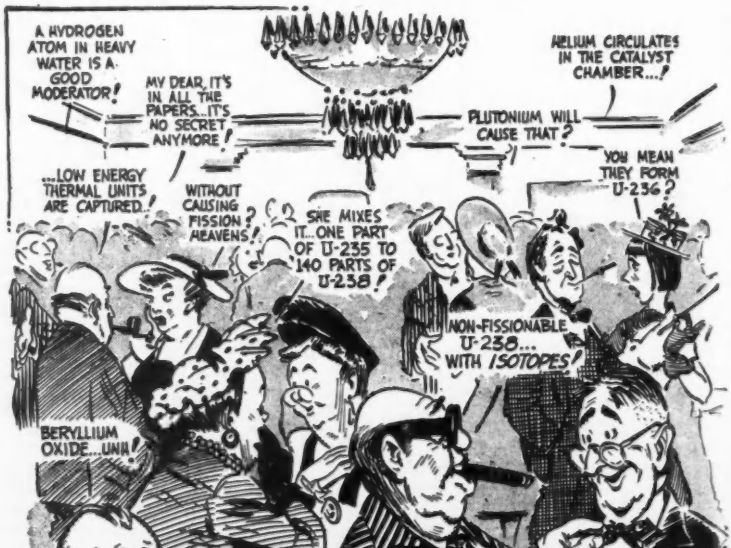
Such alloys possess mechanical properties at a temperature of 1,500 degrees Fahrenheit that are at least the equivalent of the best cobalt-base casting alloys. Of particular importance in times of international emergencies, they contain no strategic metals.

Work in searching for a new and better alloy that will withstand the extreme temperatures encountered by gas turbine blades was discussed by H. V. Kinsey of the Canadian Department of Mines and Technical Surveys, Ottawa, and M. T. Stewart of the National Research Council of Canada, also at Ottawa. In particular

they investigated what they called the nickel-rich corner of the nickel-aluminum-molybdenum system.

Commercially pure nickel, aluminum and molybdenum were used in the investigations. Proportions of each were varied. All melting was done by high-frequency induction in magnesia-lined crucibles.

In some alloys cobalt was used. Cobalt, up to five per cent, had no apparent effect on the creep-rupture properties. However, over 10% cobalt makes the alloy difficult to cast and destroys creep-rupture properties. Replacing part of the molybdenum with tungsten apparently is neither beneficial nor harmful, they stated.


A HYDROGEN ATOM IN HEAVY WATER IS A GOOD MODERATOR!
MY DEAR, IT'S IN ALL THE PAPERS...IT'S NO SECRET ANYMORE!
HELIUM CIRCULATES IN THE CATALYST CHAMBER...?
PLUTONIUM WILL CAUSE THAT?
...LOW ENERGY THERMAL UNITS ARE CAPTURED!
WITHOUT CAUSING FISSION? HEAVENS!
SHE MIXES IT...ONE PART OF U-235 TO 140 PARTS OF U-238!
YOU MEAN THEY FORM U-236?
NON-FISSIONABLE U-238... WITH ISOTOPES!
BERYLLIUM OXIDE...UNH!
GIB CROCKETT

The Atomic Energy Commission Releases Hitherto Secret Information . . .

—Gib Crockett in The Evening Star, Washington, D. C.

Government Releases Data On Three Atomic Furnaces

Low-Power Nuclear Reactors

The following information on three types of successful nuclear reactors has been declassified and released by the governments of the United States, the United Kingdom and Canada in order to make public the information necessary to the design, construction and operation of specified low-power reactors for research purposes.

The three governments have determined that the release of this information "will speed the training of nuclear reactor engineers and technicians and will hasten atomic energy development in these countries, particularly for peacetime applications. It was determined that this information would not aid rival nations in the development of military applications of atomic energy. Low-power research cannot be used for producing atomic weapons or power.

"The information now releasable describes what must be known in order to assemble and operate a low-power research reactor. Before such a reactor can be built by a private institution, however, the permission of the government to use the necessary fissionable materials is required. In the United States the governmental agency which controls the use of fissionable materials is the Atomic Energy Commission."

Uranium-Graphite Reactor

➤ On December 2, 1942 man achieved the first self-sustaining nuclear chain reaction and thereby initiated the controlled release of nuclear energy. The pile, a huge cube of graphite and uranium, had been constructed by a small group of physicists of the University of Chicago's Metallurgical Laboratory.

Constructed in a squash court of the University's Stagg Field, it was operated at a maximum power level of 200 watts since higher level operation of an unshielded reactor was deemed to emit radiation in quantities which conceivably might be injurious to the operating personnel.

The operation of the West Stands reactor was terminated on February 28, 1943, and the reactor was dismantled and moved to the Laboratory's Palos Park site where it was reconstructed and provided with a radiation shield. The reconstruction was done on a very short time schedule since important information required for the design of plutonium-producing reactors to be constructed at Hanford (Washington) Works had to be procured. Only 21 days were required for the dismantling, moving, and reconstruction of the reactor, and on March 20, 1943 the Palos Park reactor, built of the same materials used at West Stands, began to function.

Description. The rebuilt reactor looks very much like a large windowless, two-story square concrete build-

ing. Its external measurements are: 30 feet wide, 32 feet long, and 21 feet high. A small laboratory has been constructed on top of the reactor in which experimental work can be performed using radiation generated within the pile.

Inside the five-foot concrete walls is the reactor core, a cube-shaped pile of graphite into which lumps of uranium have been imbedded according to a pre-determined lattice-type pattern. The type of the graphite-uranium pile is covered with six inches of lead and about four feet of solid wood.

The small experimental laboratory is constructed atop of this shield. Various controls and safety rods enter the sides of the reactor from supporting platforms built around the faces or sides of the reactor. Numerous openings are available in the front face of the reactor so that blocks of graphite, known as stringers, may be removed and test materials inserted into the active area of the reactor.

Construction. The concrete walls were first poured with the front and top open, leaving a vault in which the reactor proper could be built up, layer by layer, in a space 22 feet long and 20 feet wide. As in the West Stands reactor, the basic construction unit for the graphite-uranium reactor was a graphite block, 4-1/8 inches by 4-1/8 inches. The length of the blocks varied but most of them were 16½ inches long.

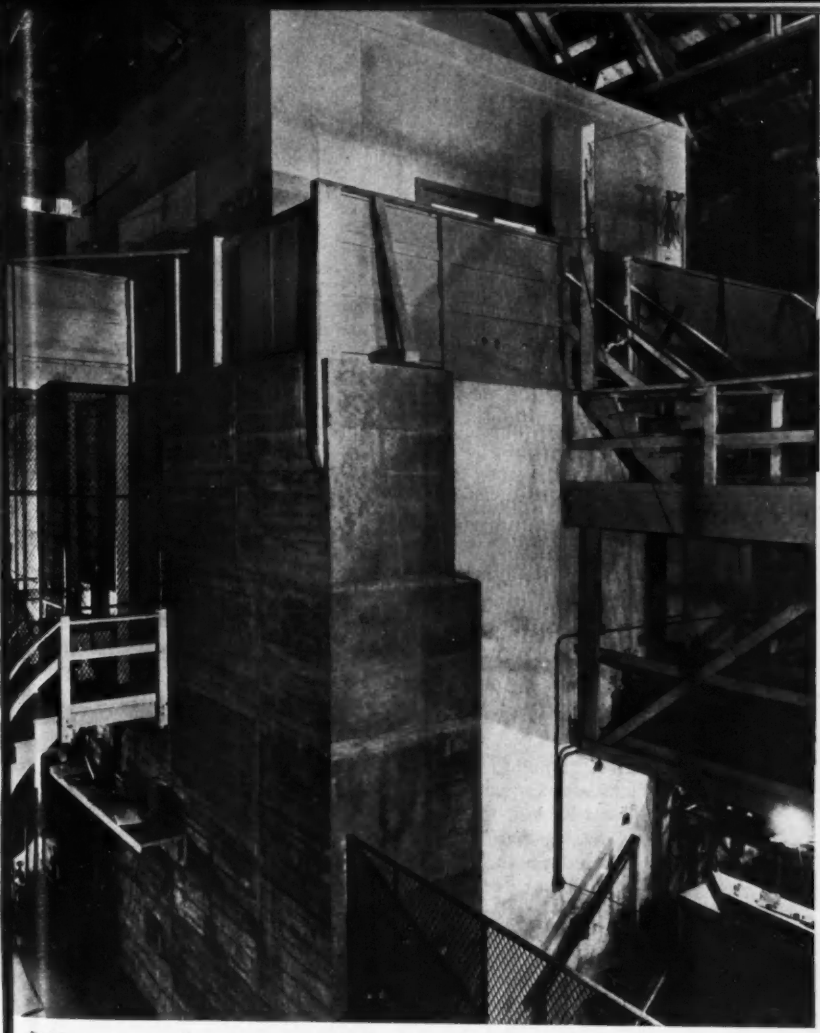
Cylindrical recesses spaced 8¼ inches from center to center were cut in the blocks. Uranium cylinders 2¼ inches in diameter and weighing about six pounds were inserted into these recesses. Blocks prepared in this manner are called "live" graphite. Other graphite blocks contained no uranium, but were used simply as spacing blocks. These are called "dead" graphite.

The graphite blocks were cut to length and the uranium bodies were placed into the recesses to provide live graphite rows spaced by rows of dead graphite blocks across the pile to form horizontal layers. Each horizontal uranium-bearing layer was spaced from the layer below by a horizontal dead graphite layer, thus a three dimensional lattice was formed. All of the blocks were closely piled so as to reduce air spaces.

In order to reflect stray neutrons back into the reactor core, the uranium-bearing material was surrounded on all sides by at least twelve inches of dead graphite. The reactor became chain reacting or critical at the 50th layer. An additional four layers of dead graphite were then added above the 50th layer to complete the reflector across the top of the reactor.

Materials Used. Because of the relatively small amount of uranium metal available at the time of the construction of the reactor, a large number of the recesses were filled with uranium oxide. To use the available metal in the most efficient manner, it was placed in the center of the reactor and was surrounded with the uranium oxide lumps. Accordingly, live graphite pieces containing about ten tons of metal lumps were piled in layers to form a central lattice mass about 13 feet wide, ten feet deep and ten feet high, which was positioned between the 16th and 48th layers of the reactor.

The reactor contains about 3,200 uranium metal lumps weighing about ten tons. About 14,500 uranium oxide



▶ THE FIRST *nuclear reactor, under the West Stands at Stagg Field, Chicago, was the site of the first self-propagating chain reaction, on December 2, 1942. On top of the pile and its thick shielding, as now reconstructed at the Argonne National Laboratory, there is a small laboratory for research on the properties of neutrons.*

lumps were used, bringing the total amount of uranium in the reactor to about 50 tons. The weight of graphite in the reactor is about 472 tons and the total weight of the reactor including the core, reflector, shield, and lead top is in excess of 1,400 tons.

Control System. As the reactor was being built, various slots or openings were provided for the control, shim, and safety rods. There are five control rods, a regulating rod and a shim rod on the north face of the reactor and three safety rods on the east face. These rods, 17 feet long, are bronze strips covered with cadmium which is an excellent absorber of neutrons.

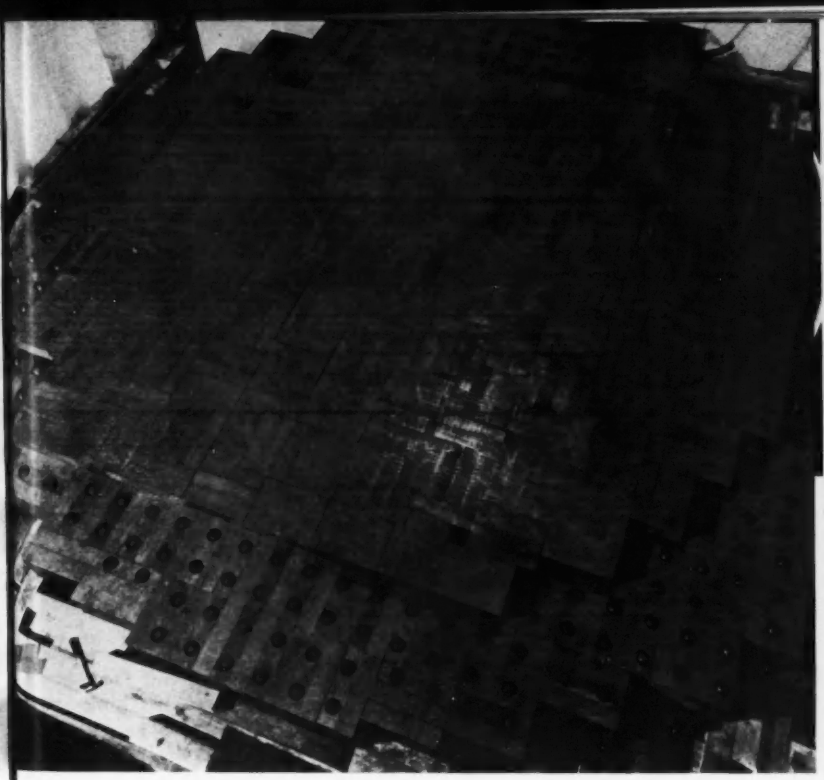
The control system is designed for manual regulation of the reactor, for automatic safety control, and for automatic manipulation of the regulating rod in a manner such as to maintain constant intensity in the reactor. The safety rods are equipped with 100 pound weights so that they are pulled into the reactor in the event of electrical power failure.

Neutron Column. Extending above the 54th layer of graphite was a dead graphite pier to act as a thermal neutron column for slowing down the neutrons and making them available for research. This column is several feet square and is about five feet high and passes through the center of the lead and wood top covering the reactor core. Some neutrons created inside the reactor pass through this column of graphite and, as a result of numerous collisions with carbon atoms, their speed is greatly reduced. The column is covered with a cadmium layer in which a small opening has been provided. Slow neutrons passing through this opening in a narrow beam are used by experimental physicists in numerous research activities.

The beam of neutrons coming from the thermal column may have a diameter as small as a lead pencil or as great as five feet, depending upon research needs. Even with the small opening, the number of neutrons involved is very large—some millions of neutrons per second. While the neutrons have been slowed down, they still travel at a terrific speed: 2,000 meteres per second, or approximately 4,000 miles per hour. On the other hand, a fast neutron speeds along at roughly 10,000 times as fast.

Instrumentation. As the construction of the West Stands reactor proceeded, a series of measurements was made to be sure that the critical dimensions were not reached inadvertently. These measurements served also to check the neutron multiplication properties of the structure during assembly, so that scientists could predict when the critical point would be reached. A similar procedure was followed in the subsequent rebuilding of the reactor.

In general, any detector of neutrons or gamma radiation can be used for measuring the intensity of the reaction. During the construction of the West Stands reactor, a 2 by 2 inch slot running from the north face of the pile to slightly beyond the center of the pile was built into the eleventh layer. A boron trifluoride proportional counter in a graphite block was pushed along this slot to the center of the eleventh layer. The counting of neutrons was thus achieved and instruments, located outside the reactor, made a continuous record of the



➤ CONSTRUCTION *of the lattice which forms the atomic pile, in the Argonne National Laboratory. Layers of "live" graphite blocks, containing uranium, alternate with "dead" blocks of solid graphite. Holes run through the structure at intervals for insertion of control rods and experimental equipment.*

counting rate. To detect the radiation at the periphery of the rebuilt reactor, an ionization chamber was installed inside the concrete shield near the safety rods.

Fission Process. The principle of operation of a nuclear reactor is simple enough. If in a mass of uranium one neutron causes a fission to occur resulting in the formation of two or more neutrons, it is conceivable that the number of fissions may increase steadily with the consequent release of sizeable amounts of energy. However, there is a great competition for these neutrons and the question of whether a chain reaction does or does not take place in a given structure depends upon the result of a competition among four processes. These are:

(1) escape of the neutron to the outside.

(2) non-fission capture of the neutron by urnanium.

(3) capture of the neutron by impurities in the construction materials.

(4) fission capture of the neutron by uranium.

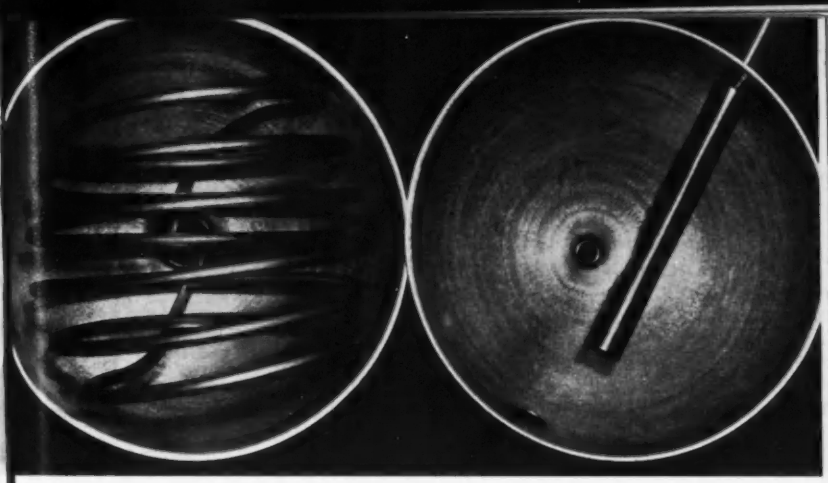
It is obvious that a chain reaction will occur if the number of new neutrons, created by the fourth process, exceeds the loss of neutrons due to the other three processes.

Moderator. The relative chance of fission capture as opposed to competing non-fission processes depends upon the speed at which the neutron travels. The chance for fission increases if the neutron is traveling slowly. Fast neutrons are slowed down in passing through materials of low atomic weight. The greatest loss of speed per collision would occur if the neutron and the atoms of the moderating material had identical weights. This condition cannot be met in nature, but hydrogen, whose atoms weigh approximately the same as the neutron, is a good moderator and low-weight deuterium (heavy hydrogen), beryllium, and carbon are effective moderators.

While no one of these elements may be excluded from the list of possible moderating materials, it was decided West Stands reactor would be constructed with graphite, a form of carbon. Experiments have shown that high speed neutrons resulting from the fission process are practically all reduced to low speeds, suitable for fission capture, after passing through about eight to ten inches of graphite. It has been estimated that about 110 collisions with graphite atoms take place during this slowing down process.

Neutron Capture by Impurities. Very careful purification of the uranium and of the moderator is necessary to reduce the number of cases of non-fission capture of neutrons by impurities. Calculations have shown that the maximum permissible amount of impurities are a few parts per million in the uranium or the moderating material. Not only was the amount of uranium available in 1942 and 1943 very limited, but both the uranium and graphite were of doubtful purity. It is to be noted that prior to 1940 the amount of uranium produced in this country was very limited and that graphite had never been produced in quantity with anything like the purity that was required of a moderator.

Reproduction Factor k. The whole success or failure of the construction of the first nuclear reactor depended upon the reproduction factor k. Suppose that there is a given number of neutrons present in a graphite-uranium system at a given time. Some of these neutrons, under proper conditions will cause fissions to occur and thus new neutrons will be released. The ratio of the number of newly created neutrons to the number of original neutrons is known as the reproduction factor k. Thus, if 100 neutrons cause the production of 105 neutrons, factor k is 1.05. If this number is greater than 1, the chain reaction is assured. If k is less than 1, the chain reaction could not exist because the neutron population would steadily decrease.



▶ TWO HALVES *of a stainless steel sphere used to contain enriched uranium fuel solution in the Los Alamos "Water Boiler." The coil shown is part of the system for circulating cooling water. The straight tube is one section of the "glory hole" running horizontally through the reactor in which materials can be subjected to neutron bombardment.*

Heavy Water Reactor

Because there was always the remote chance that graphite moderated nuclear reactors could not produce the fissionable material required for the program of the Manhattan Project, much thought was given in 1943 to the construction of a heavy water moderated reactor. In consequence, the production of heavy water in sizeable quantities was undertaken (at other locations) early in the development of the atomic energy program. Measurements performed on heavy water with the use of the graphite moderated pile during the summer of 1943 proved the feasibiliy of a heavy water reactor and had produced sufficient information to permit its construction.

Construction of a building was begun in September, 1943 and on May 15, 1944 the heavy water reactor was operated at low power. Thus, it became the world's first heavy water nuclear pile.

Description. In comparison with graphite moderated reactors, the heavy water reactor is quite small. It consists of an aluminum tank, six feet in diameter and eight feet-ten inches high, which is filled with approximately six and a half tons of heavy water (amount contained in 32,000 tons of ordinary water) and into which are suspended 120 uranium metal rods, 1.1 inches in diameter and six feet long. The uranium rods, whose total weight is nearly three tons, are arranged to form a square lattice with the distance from center

to center being 5-3/8 inches. Heavy water, which is present in ordinary water as one part in 5,000, serves to slow down the speed of the neutrons in the same manner and for the same reason as is accomplished by graphite in the other reactor. Heavy water is more effective than graphite in slowing down neutrons and does not absorb neutrons as readily as does graphite. To remove the heat created in the fission process, the heavy water is circulated through a heat exchanger. Thus, the heavy water serves not only as a moderator, but as a cooling agent as well.

The reactor tank rests on a two-foot layer of graphite blocks supported by the concrete pile foundation. The graphite reflects the neutrons to the reactor core. In addition to this neutron reflector on the bottom, the sides are provided with a reflector of equal thickness.

A four-inch shield of lead-cadmium alloy surrounds the reflector and fits snugly against a thick concrete shield which encases the entire reactor. The lead-cadmium alloy protects the concrete from exposure to neutron and gamma radiation. A one-foot shield of lead bricks is placed on top of the graphite reflector and is continued over the top plate of the reactor tank. Between the bottom of the lead cover and the top plate of the reactor tank is a thin layer of cadmium metal.

Neutrons escaping from the uranium section of the reactor are slowed down by collisions with atoms in the heavy water and are then absorbed by the cadmium shield. This absorption of neutrons causes the cadmium to emit gamma rays which are in turn stopped by the lead shield. (The capture of a neutron by any material immediately results in the formation and emission of a gamma ray). Thus, personnel during the loading and unloading of fuel are protected from neutrons by the cadmium and from gamma rays by the lead. The thick lead shield at the side and bottom contains copper tubing for circulating cooling water to remove the heat generated in the shield and in the graphite.

The space between the heavy water and the cover of the tank is filled with helium. This inert gas replaces ordinary air which would normally be present and which must be kept out of the system. Moisture, in the air, would be condensed inside the reactor tank and would dilute the rare and expensive heavy water. There is another objection to the use of air. Inasmuch as nitrogen makes up about four-fifths of the atmosphere, radiation bombardment of air would result in the formation of nitric acid.

Two blower pumps circulate the helium through a cooler and through a catalyst chamber. These pumps, one of which is normally a stand-by pump, circulate the helium gas and dissociated heavy water. Under neutron bombardment heavy water molecules break apart to form oxygen and heavy hydrogen and these gases are recombined in the catalytic chamber and returned to the reactor tank.

Concrete Biological Shield. The reactor core is surrounded with a biological shield which is in the form of an approximately octagonal concrete prism thirteen feet high and having walls eight feet thick. The top of the reactor is shielded with a four-foot layer of blocks of wood and steel

weighing eighty tons. Only five of the eight faces of the reactor are visible because the cooling machinery room encloses within itself three of the faces.

Experimental Openings. Eleven openings, closed by removable shielding plugs, penetrate the biological shield and the graphite reflector to provide facilities for measuring the neutron intensity of the reactor, for exposing materials to neutrons, and for permitting the passage of beams of radiation from the reactor. Four of these openings contain ion chambers (neutron detection instruments) used in operating the reactor. The other seven may be opened to permit the passage of beams of neutrons or may be used to introduce materials into the reflector near the reactor tank for making them radioactive by exposure to neutrons.

On the east face of the reactor is a large opening (roughly 30 inches square) also used for irradiating materials by neutron exposure. The opening contains twenty hollow graphite stringers to hold materials to be irradiated.

Neutron Column. A thermal neutron column carries a beam of slow neutrons from the reactor. The column consists of a stack of ordinary graphite blocks five feet square and seven feet-eight inches long extending back to the neutron reflector. The end extending through the concrete shield is covered with a cadmium curtain and a two-foot lead and iron shield in which an eight-inch square opening is provided. Neutrons created in the reactor are slowed down, to be in equilibrium with the room-temperature or thermal agitation of the graphite molecules, by repeated collisions with graphite atoms. When needed in research experiments, they leave the reactor through this opening. The size of the opening may be altered by changing the size of the cadmium cover.

Rabbit. In many experiments, materials made radioactive in the reactor must be removed from the reactor in a short time. To speed their insertion into and removal from the reactor, materials which lose their radioactivity after a few seconds travel in a pneumatic tube arrangement called the rabbit, built into one of the eleven openings passing through the concrete shield. Materials to be irradiated are placed in small plastic cylinders and shot in and out of the reactor. Helium gas, which does not absorb neutrons and become radioactive, furnishes the push which speeds the samples in and out of the reactor.

Central Experimental Thimble. In addition to the eleven openings in the sides of the reactor described above, an opening known as the central experimental thimble extends from the top of the reactor into the heavy water. This opening has been made by extending a four inch aluminum pipe from the center of the top shield, through the tank lid, and down to within a foot of the aluminum tubes through which various samples may be lowered into the center of the reactor for exposure to fast and slow neutrons. Thirty-two irradiations may be performed simultaneously by the use of this facility.

Control System. The Argonne heavy water reactor is equipped with two control rods, two safety rods, and three shim rods. All contain cadmium

metal so that they will absorb neutrons and stop the chain reaction.

The safety and control rods are each formed of a 3½ inch tubular sandwich of 1/32 inch cadmium placed between two aluminum tubes. These rods are hinged to the bottom side of the cover of the heavy water tank. When they are in the "in" position (reactor would not be operating), they are hanging about 30 degrees from a vertical position. When the rods are in the "out" position, they are suspended in an almost horizontal position above the water in the tank. Those rods move through a sixty degree arc.

The shim rods, sometimes called auxiliary control rods, are contained in aluminum tubes and are mounted inside the tank in a vertical position with one end of the rods pentrating through the top of the reactor tank.

Cooling System. The heavy water is pumped from the top of the reactor, passed through a heat exchanger located in the adjacent pump room, and fed back into the reactor tank through an opening at the bottom of the tank. In this way, 300 kilowatts of heat is removed from the reactor. The heavy water flow rate is 200 gallons per minute. Experiments have shown that this rate of flow produces only a minor ripple in the surface of the water and experience has shown that this ripple does not introduce any instability into the reactor.

In normal operation, the average temperature of the heavy water flowing from the tank to the heat exchanger is 95° Fahrenheit while the heavy water being re-introduced into the reactor is, on the average, about seven or eight degrees cooler.

The heat exchanger permits the heat to flow from the heavy water to the cooling water, but does not permit the flow of heavy water into the light water. There is a certain amount of radioactivity associated with the heavy water, but there is no way for this activity to be transmitted to the cooling water. Should a leak occur, radioactive heavy water might enter the light water cooling system, but Geiger counters inserted in the cooling line would immediately reveal the presence of radioactivity and necessary steps to prevent further loss of the valuable heavy water would be taken.

Operation of the Reactor. The controls for operating the reactor are located in a room near the reactor's north face. Here, an operator may measure and control all of the major aspects of the reactor's operation. To start the reactor, the operator merely pushes a button and the 32 pound safety rods are pulled out of the reactor. By pressing another push button, one of the two motor-driven control rods is removed. To shut off the reactor, the operator causes the safety rods to fall back into vertical positions inside the tank. If the power of the reactor should become too great, if some of the controls should fail to function, or if there should be an interruption in the electrical power supply, the safety rods would automatically fall into the "in" position by gravity and the reactor would shut down immediately. As a further measure to cause a sudden stop in the operation of the reactor, a properly located large quick-opening valve can

discharge the moderator by gravity to a storage tank.

The shim rods are usually not moved but are allowed to remain fairly constant in day to day operation. Occasionally, however, they are adjusted when materials are irradiated in the reactor. For example, if a material possessing great ability to capture neutrons is placed into the reactor for irradiation, the shim rods will be withdrawn to reduce the amount of neutron capture by the cadmium in the shim rods, thus making more neutrons available for capture by the newly-introduced sample. Conversely, in some instances, the rods would be lowered deeper into the water so as to increase the number of neutrons being captured.

Los Alamos Water Boiler

Plans for the Water Boiler, a homogeneous chain reactor using as fuel an enriched uranyl salt solution in water, were started in August 1943 at the Los Alamos Scientific Laboratory, Los Alamos, New Mexico.

Preliminary calculations for the proposed reactor were carried through by R. F. Christy and the design for the first model (LOPO) was completed and developed by a group of research workers under the direction of D. W. Kerst. A second high-power model (HYPO) was later designed and built under the leadership of L. D. P. King with the advice of E. Fermi and the chemical work was done under the direction of L. Helmholtz.

Basically, the Water Boiler, as developed up to January 1950, consisted of a container filled with an enriched uranyl solution surrounded by a neutron reflector and necessary radiation shielding, with the necessary control rods to regulate the power level and a cooling system to carry off heat generated by the reaction.

Low-Power Reactor. The original water boiler design for a low-power reactor (LOPO) was completed in November 1943. It was decided to build this device before attempting the later model reactor of higher power. In the low-power unit the shielding and cooling problems were eliminated. At the same time its operation would indicate to what extent gases might be evolved from fission fragments and decomposition of the water and would reveal unforeseen difficulties in keeping the salt solution critical.

A separate building for LOPO was erected at a location remote from the main portion of the technical area at Los Alamos. Assembly proceeded through the spring of 1944 and the system became critical in May 1944 with 1.2 pounds of U-235. The highest power to which LOPO was run during its several months existence was about 50 milliwatts, which raised the temperature to about 94 degrees Fahrenheit.

Members of the LOPO research group recall an incident involving Dr. Christy, who performed the theoretical studies and calculations which indicated that a water boiler reactor was feasible. As the reactor passed from the drawing boards to construction Dr. Christy became more and more convinced that the theory was correct and that his estimates of the amount of fissionable material re-

quired and of the correct setting for the control rods were exact.

Despite this confidence on the part of the designer, the reactor was started cautiously with careful adjustment of control rods and gradual filling of the fuel container. However, when the critical point was eventually reached, Dr. Christy was proved correct. Both the amount of fuel and the control rod settings were exactly as he had foretold.

In view of the successful operation of LOPO, it seemed desirable to construct the high-power unit which would provide a more intense neutron source.

High-Power Reactor. HYPO went critical in December 1944 with about 1.8 pounds of U-235, although the normal loading contains about 1.9 pounds of U-235. Except for minor design changes, HYPO, as originally constructed, has operated successfully for several years.

The Los Alamos Water Boiler has been used primarily for physical experiments requiring a concentrated neutron source. It is the smallest and most economical type of chain reactor so far built. The peak power of HYPO was about 6 kilowatts, representing a neutron flux of about 300 billion neutrons per square centimeter per second at the center of the reactor. A slow or thermal neutron flux of the order of a billion neutrons per square centimeter per second is available for research purposes in the graphite tamper surrounding the reactor.

The heart of the reactor consists of a one-foot spherical stainless steel container filled with a uranyl nitrate solution in water, known to the Los Alamos scientists as "Soup." The uranium in the uranyl salt contains about 1 part of fissionable U-235 isotope to 6 parts of nonfissionable U-238 compared to ordinary uranium which contains 1 part U-235 to 140 parts of U-238.

Surrounding the container is a reflector, or tamper, consisting of an inner core of beryllium oxide supplemented by a shell of graphite. The reactor and tamper occupy a cube about five feet on a side. A considerable amount of shielding is also necessary to protect operating personnel. The shield around the entire assembly consists of 4 inches of lead, 1/32-inch of cadmium, and 5 feet of poured concrete.

At the front or working face of the reactor a square tunnel pierces the shield. This tunnel was plugged with graphite to form a graphite thermal column and a number of ports for experimental irradiations were placed in the column and the tamper. A one-inch tube also extends through the shield, tamper and through the reactor sphere itself. Los Alamos workers call this the "Glory Hole." It permits materials to be irradiated at the highest neutron flux level.

Because of its low-power, LOPO required no cooling system. In HYPO, however, a six-turn cooling coil of ½-inch tubing and having an effective length of 157 inches is wound in the form of a helix inside the sphere. About 50 gallons of water per hour is pumped through the cooling system which is sufficient to permit year-round operation at six kilowatts. After passing through the reactor the cool-

ing water is retained for a short time in a tank within the shielding to permit short-lived induced radioactivity to die down before it is released.

When operating, the water in the fuel solution is decomposed by the highly ionized fission products forming about one-half cubic foot of hydrogen and oxygen gas per hour. Since this chemical mixture is extremely explosive and also since highly radioactive gases are produced in fission, some means of diluting and flushing out these gases was required. This was accomplished by means of a double inlet-outlet tube welded to the top of the sphere. Air is pumped through the inner ¼-inch tube and is exhausted through the outer ¾-inch tube. The inner tube may be raised or lowered so that it acts as an indicator of the solution level. Also by leading the gas from the outlet tube through test equipment, rapid analysis of the boiler gas may be made.

Copper-constantin thermocouples for measuring temperatures are placed in a tube extending into the center of the sphere and are also connected to the water inlet and oulet tubes.

HYPO is controlled by means of a cadmium shim rod, two cadmium control rods, and a cadmium safety rod. The latter always remains out during operation, since it is used only to stop the chain reaction in case the intensity should get too high. For additional safety, the two control rods are designed with a release mechanism so that they can stop as well as control the reaction. If both control rods and the safety rod are dropped at the same time, the neutron intensity falls 85 per cent within one second.

Under normal operating conditions the Water Boiler is self-regulating due to the temperature effect. As the temperature increases the volume of the solution expands and the reactivity per unit volume declines. This automatically slows down the reaction so that under normal conditions it is impossible for the reactor to get out of control. If the control rods are pulled out too rapidly, however, the heat release could possibly be non-uniform through the solution. For very short times, say 1/50 second or so, local hot spots might arise in which the solution would vaporize before the increased temperature had time to control the activity. In such cases the control rods would drop automatically to stop the reaction before serious damage to the reactor could occur.

The neutron flux is measured continuously by means of an ionization chamber, coated with uranium 235. The U-235 atoms in the coating undergo fission when hit by neutrons and the highly charged or ionized fission products can be detected by the chamber. The detection circuit leads into a very sensitive galvanometer in which the amount of electric current registered is proportional to the neutron flux. Independent U-235 chambers are used to trigger the safety and shim rods, which drop whenever a predetermined intensity is reached.

Extremely accurate control of the Water Boiler requires almost continuous adjustment of the control rods. This can be done by hand, but the job is tedious over long periods and so an automatic pilot has been designed to maintain the power at any fixed level.

Operation. All operations necessary to starting, running, and stopping HY-

PO are done from the control desk located in a room adjacent to that containing the reactor. Indicator lights and various warning signals aid the operator in controlling the reactor and locating difficulties.

The typical operating procedure for HYPO is as follows: Readings are made and recorded of the U-235 ionization chamber power indicator, solution level and sphere temperature. The flushing air and cooling water are turned on, and the direct-reading galvanometer is set on maximum sensitivity. The control rods are checked for "IN" position. The safety deflection is observed. After the first control rod is at the "OUT" position, the second rod is raised until the desired operating level is reached on the galvanometer. The automatic pilot can then be switched on to maintain constant power.

The reactor responds very rapidly to change in the control rod position, and this may be changed as rapidly as the operator desires. An experienced operator can bring HYPO up to full power in a few seconds.

With an inlet water temperature of about 45 degrees Fahrenheit and 1.9 pounds of U-235 in the boiler, HYPO could run continuously at 5.5 kilowatts without exceeding a solution temperature of 185 degrees Fahrenheit, if this should ever become necessary. At this power level, some excess reactivity is available for experiments on materials which absorb neutrons.

After reaching a constant operating temperature corresponding to a power level of one kilowatt or more the reactor will maintain an operating level constant to within a few tenths of one per cent or better.

At Los Alamos a small chemical laboratory was erected near the HYPO site to recycle the fuel solution and to remove fission fragments. An underground stainless steel conduit was installed to carry the soup from the reactor to the chemical apparatus.

Since the successful operation of HYPO, the Water Boiler has been modified and improved in a number of ways to provide more efficient operation at higher powers. The details of these later improvements have not yet been declassified.

Members of the research groups responsible for design, assembly and operation of the two Los Alamos Water Boilers are listed below:

Research group for LOPO

D. W. Kerst, group leader, R. F. Christy, advisor, C. P. Baker, F. L. Bentzen, J. Bridge, R. E. Carter, H. Daghlian, G. Friedlander, H. Hammel, J. Hinton, F. de Hoffman, M. G. Holloway, L. D. P. King, H. M. Lehr, J. H. Midney, R. E. Schreiber, J. W. Starner and P. H. Watkins.

Research group for HYPO

L. D. P. King, group leader, E. Fermi, advisor, H. L. Anderson, F. L. Bentzen, J. Bridge, R. E. Carter, L. Helmholtz, J. Hinton, D. Nagal, J. C. Nevenzel, R. E. Schreiber, J. W. Starner, J. Tabin, and P. H. Watkins.

The names of the scientists working with the current or super-version of the Water Boiler are: L. D. P. King, group leader, M. E. Bunker, R. E. Carter, J. E. Evans, J. R. Phillips, J. W. Starner, W. E. Stein, B. E. Watt. The Chemistry Group consists of P. R. Hammond, in charge, H. M. Busey, A. S. Gurney, J. A. Leary, J. W. Schulte and W. R. Wykoff.

Data for Low-Power Research Reactors

A number of technical papers on design, construction and operation of the declassifiable low-power reactors are being prepared by the individuals who have taken part in this research in the United States, United Kingdom and Canada. They will appear in the scientific and technical journals in the normal fashion.

In addition, certain data on the nuclear properties of uranium having significance in the design and operation of low-power reactors also will be released through technical articles in scientific journals. The following summary has been prepared to point up the unique features of this technical data.

Of most general interest is the fact that the low energy, thermal, neutrons are captured in appreciable quantities by Uranium-235 without causing fission. It would be inferred from earlier studies of fission, that almost all thermal neutrons captured by fissionable Uranium-235 would result in fission. However, as the technical articles will reveal, a significant fraction of all thermal neutrons colloding with U-235 are captured to form U-236. Engineers designing uranium reactors must keep this fact in mind since these captured neutrons are not available to continue the chain reaction.

A more precise value for the number of neutrons produced on fission of Uranium-235 by thermal neutrons will also be reported in technical articles. This number hitherto has been quoted as between 2 and 3.

Other data to be declassified in technical releases include a description of the energy distribution of the neutrons released instantaneously when Uranium-235 is fissioned by thermal neutrons, and a formula showing how "lumping" the natural uranium in low power piles affects the capture of neutrons during their slowing down process. All of these data are necessary for training nuclear reactor engineers and in designing low-power research reactors utilizing uranium for their fuel.

Rocket Uses Smokeless Powder

➤ BOOSTER ROCKETS, used to help get fighter planes quickly into the air from the decks of Navy carriers, need no longer cloud the vessel in smoke.

A new rocket, developed for the Navy by the Allegany Ballistics Laboratory, Cumberland, Md., uses smokeless powder for fuel. Although the new unit weighs considerably less than present types, it provides an equal amount of thrust.

Rockets used to provide extra power to planes at the takeoff are called JATO for short. The letters stand for "jet assisted take-off." They are used on carrier decks and short runways at airports to get planes into the air more quickly than can be done by engines alone. The rockets are dropped when they have done their job.

Smokeless powder has been used for some time as a propellent charge for military and naval guns. This is said to be the first JATO to employ it. For its development, both Army and Air Force contributed funds. All three services plan to use the new rocket.

Today Over 1100 Different Products Are Made from Crude Oil as Raw Material

The Rise of Petroleum Research

by Dr. M. E. Spaght
President, Shell Development Company

Extract from address during open house at research laboratories, Emeryville, Calif., Nov. 21, 1950.

➤ Technical research is a logical activity in a competitive economy. Where change is scientifically possible and the results of change are considered worth while by the economy, the individual turns to scientific research as a competitive means of maintaining or improving his position.

The petroleum industry in America invests over one hundred million dollars per year in research to improve its products, develop new ones, invent new processes, and improve existing conditions. Obviously, this investment would not be made unless we believed that the opportunities for technical change in this industry are still great—great enough to merit the labor of over 10,000 people.

Organized scientific research is a relatively new activity for man, being much less than a century old and having gained stature in America only in recent decades. Concentrated research in the petroleum industry started only after World War I.

When petroleum was first pumped from the earth in Pennsylvania nearly 100 years ago it was a curiosity and its potentialities as a fuel and chemical base material were undoubtedly appreciated by extremely few scientists, let alone anyone else. As compared with other available fuels, all of which at that time were solid, petroleum, however, possessed at least two extremely important advantages; firstly it was a liquid, hence easy to move and apply, and secondly it represented an extremely concentrated source of heat.

It was really only with the development of the internal combustion engine that liquid fuel became of commercial importance. There ensued the now classic story of the parallel development of the engine and its fuel, gasoline. Today liquid fuels from petroleum supply over one-half of the total energy requirements of America. Primarily used as a source of heat—whether under a steam boiler in a locomotive or ship or your apartment building, in a diesel engine, a gasoline engine, or in a gas turbine—petroleum is consumed in the United States at the rate of over five million barrels per day. If all of this volume were burned, which is very nearly the case, this would be a heat release of 30 million million b.t.u., equivalent in power to about 350 Hoover Dams.

It would seem that the processing of crude petroleum merely to segregate different grades of liquid fuels to be burned would be a simple job and would not require any profound knowledge of chemistry and physics.

However, the scientist, and through him the businessman, recognized the potentialities of research applied to petroleum. It was seen that the characteristics of nearly every product could be improved through scientific study, that much greater control could be gained over the relative portions of different products obtainable from a volume of crude oil, and perhaps most intriguing of all, in petroleum man had found an extremely versatile chemical mixture from which he could make not only liquids to burn but synthetic chemicals and many useful materials such as asphalts, waxes and lubricants. Today our Shell companies market over 1100 different products from petroleum, extending from gasolines, lubricants and fuel oils to highly specialized resins, plastics and synthetic chemicals.

Perhaps a more careful look at a few specific products and groups of products will illustrate what progress has been made and what remains to be done.

Crude oil as pumped from the ground contains on the average perhaps 20% of material that can qualify as gasoline and, except in a few instances, that naturally occurring gasoline is of unsatisfactory chemical structure for use in today's automobiles or airplanes. Compared with this 20% of gasoline occurring in crude oil, the American petroleum industry today markets as gasoline approximately 44% of its crude oil intake, and most of the molecules of that 44% have been changed from the form in which nature gave it to man.

A long line of technical accomplishments has made this evolution possible, including the now well-known processes of thermal cracking, catalytic cracking, polymerization, hydrogenation, isomerization, etc. By the end of World War II, America was producing over one-half million barrels daily of aviation gasoline, of which most of the ingredients were synthetic and with properties which made possible the development of the superior aircraft engines. Motor gasoline today contains the catalytic products and synthetic components which have come about from this long line of technical achievements. The end of research and progress in gasoline is not at hand.

One of the outstanding technical accomplishments since the war has been the development of new catalytic reforming processes for natural gasolines which allow higher yields of higher quality gasoline from each volume of crude oil. Shell has announced its plans for installation of two of these catalytic reforming units, the first company in America to announce plans for construction.

It seems curious that the raw material that yields fuel for our machines should simultaneously give us their lubricants. There are simple technical reasons why liquid hydrocarbons, petroleum, are fine fuels, yet the fact that high boiling hydrocarbons behave as lubricants would not be equally obvious. Actually not all of them are good lubricants. Perhaps the most pertinent observation was that certain of the high molecular weight, or high boiling, portions of crude oil are indeed excellent materials for reducing the friction between two moving surfaces. With this fact in mind the problem then became first one of segregating out the most desirable naturally

occurring constituents from the least desirable ones, and there were developed then the now well-known processes of solvent extraction.

The resulting refined lubricating oil was still deficient in certain respects; for example, it would oxidize on aging, become badly fouled, and certain engine parts would corrode. In an attack on these shortcomings it was found that specific chemical compounds could be made which when added in small amounts to the lubricating oil would inhibit one of these undesirable characteristics. As the result of prolonged work, characterized by some of the best scientific progress of our industry during the past several years, the finest lubricating oils today are highly specialized mixtures which are infinitely more stable, more wear resistant and better lubricants than their predecessors of yesterday.

Here again the end of progress is not in sight. As we improve lubricating oils the engine manufacturer is encouraged to make greater and greater demands on them. He redesigns his bearings and his pistons in some fashion to improve the performance of his engine. In turn our research aimed at servicing the engine's more stringent demands leads us into new areas of development which result in still better oils.

The result, of course, in the foreseeable future is the continuing parallel development of machines and of the lubricants for them and it can only mean that your engines and mechanical devices of tomorrow will be still better and more efficient and more convenient than those of today.

At the turn of the 20th Century, German chemistry was leading the world on the path of synthesizing certain chemicals that had heretofore been commercially unavailable or had come from reluctant sources. In 1895 after 15 years of research the German scientist, von Baeyer, was able to synthesize the dye indigo from coal tar. At that time indigo was obtained from the indigo plant growing in India. Twenty years later the price of indigo had dropped to a quarter of its previous figure, the synthetic product was technically better and more constant in quality, and natural indigo, unable to compete, dropped from the market.

Chemicals by synthesis became a byline of the early 20th Century and today the chemical industry is the fastest growing segment of the American economy. Through the necessities imposed by World War I, America took up with vigor the synthesis of organic chemicals. At that time the synthetic materials were made largely from coal tar and from fermentation of natural materials, such as molasses and grains. Synthetic dyes, phenol, alcohols, ketones, acetic acid, and other compounds came on the market as products of American chemistry. Petroleum was at that time an insignificant chemical raw material. With the growth of synthetics and the great promise that the chemical industry held for further development, the scientist looked about for new raw materials and without much surprise saw in the low boiling fractions of petroleum a vast, cheap supply of extremely versatile raw material. How sound his observation was is seen when one points out that today, 30 years later, over one-half of the total synthetic organic chemicals in this rapidly expanding segment of

our economy are produced from petroleum.

You will understand our pride in pointing out that Shell Development has been an outstanding pioneer in the petroleum industry in the development of chemicals. Shell Chemical Corporation today markets a long line of synthetic alcohols and ketones, resin and plastic intermediates, glycerine, ammonia, lubricating oil additives and many others. In 1948 Shell Development Company received the Chemical Engineering award . . . "recognizing the important contributions of a great pioneering organization in the petrochemical industry." The specific citation was for the successful synthesis of glycerine from petroleum, but the award also recognized "a long-time program of pioneering in petro-chemicals and other outstanding applications of chemical engineering in the petroleum industry."

Here again the story is not finished. New products and new ventures in the chemical field lie ahead for Shell and the petroleum industry. A sizeable share of the research in Shell Development Company is directed to expanding the list of chemicals derived from petroleum.

The American petroleum industry now expends for scientific research $2.56 per year for every family in America to improve its products, to make new products, and to increase the utility of petroleum to the public. This investment in research will be limited only by the ability of scientists to propose worthwhile new subjects of investigation. As long as petroleum continues to be eligible for continued scientific study, that long will a free American industry continue this investment in research. Shell Development is proud to be playing a leading role in this field of technical adventure.

Volcanic Ash Shows How Soil Forms

➤ FERTILE SOIL is the foundation of human life. On Mt. Katmai in the Alaskan Peninsula is the one place in the world where men can study, at first hand, the steps by which soil is built, Prof. Robert F. Griggs of the University of Pittsburgh told U. S. and Canadian scientists at a recent Alaskan Science Conference.

Katmai Volcano blew up in 1912, one of the two great eruptions in the past century. The other was at Krakatao in the East Indies in 1883. Around both were laid down thick layers of pure, sterile volcanic ash. These have been the only explosions, within the era of modern science, which have afforded an opportunity for studies of how soil starts.

So far, Dr. Griggs said, no one has ever witnessed the formation of a mature soil from dead minerals. Studies were conducted at Katmai up until 1930; even then, ash lying as it fell was entirely inhospitable to ordinary plants. Now, he reported, revegetation has begun. Plants have come in on the ash.

Dr. Griggs recommended a thorough survey of the area, with all present knowledge of soil micro-organisms and chemistry brought to bear. Katmai offers an opportunity for research not to be duplicated elsewhere on the globe, he said. But the opportunity is in danger of being missed.

Rust Damage is Enemy In Various Industries

Corrosion Fought by New Chemical

➤ MICA FLAKES are the secret of success of a new, three-decker corrosion-resistant paint developed by the Westinghouse Transformer Division, at Sharon, Pa.

It is primarily for protecting the familiar steel neighborhood transformers which step down the electrical voltage from distribution lines so that the current may safely be used in buildings. Other applications are possible, however, particularly where seacoast atmosphere makes other paint coatings unsatisfactory.

The mica flakes are used in the middle coating of this triple protective covering, and are embedded in a syrup-like plastic. They ward off the attacks of moisture and oxygen, principal causes of rust, J. G. Ford, Westinghouse engineer, states. They also increase the heat resistance of the middle coat as much as ten times at high temperatures.

The inner coating of the three-decker paint is a special primer that clings tightly to the steel surface and seals it from contact with the air. The second coat, with its pigment of mica flakes, is then applied and allowed to dry. The third coat is applied to give the transformer a pleasing appearance and to shut out ultraviolet radiation from the sun. All three coats are necessary. Each layer adds to the strength and resistance of the others.

The new coating has been thoroughly tested. Exposed continuously for 18 months on seacoasts of Florida and California, it showed absolutely no signs of corrosion, Mr. Ford said. Because of this high resistance to moist, salty air, it has been named "Coastal Finish."

Measuring Paint Thickness

➤ THE THICKNESS of paint and varnish coatings and how rust and tarnish form on metals were among the subjects being studied with new techniques described recently to a special symposium of the New York Academy of Sciences.

Dr. Jean-Jacques Trillat, director of the X-Ray and Electronics Laboratory of the French National Scientific Research Center, described these new methods as well as a new apparatus devised to help in the measurement of coating thicknesses.

Use of X-rays and photoelectrons (charged particles thrown out from a surface by the action of light or other radiation) to study the surfaces of metals, alloys and minerals is one of the techniques. Another method is the use of X-rays to analyze thin surface films on paper and biological objects. Still another method is use of X-rays that have been diffracted, or changed from their original path, to study corrosion and lubrication.

The new apparatus measures the angles between X-rays and the films at which the X-rays are directed. From them can be calculated the

thickness of such substances as paint and varnish. The method also can be used to study the oxidation, or rusting, process; to identify alloys and to learn about the effects of surface polishing of metals.

Another technique described to the Academy of Sciences makes it possible to prepare a metal surface in a vacuum. This surface can then be machined in the vacuum at any desired temperature, thus permitting new research into the study of metal surfaces. It further allows the scientists to distinguish the physico-chemical factors, such as adsorption and chemical affinity, from the structural factors.

This new method helps laboratory study of the fresh, clean surfaces of solids, of the measurement of surface temperatures, of the results of machining metals and of how rust and tarnish form.

Dr. Trillat is a professor at the Sorbonne and an officer of the French Academy.

Pitting Injures Hulls

➤ THE FORMATION of pits in steel in sea water, not general corrosion of the entire hull of a steel vessel, is an important problem to ship operators. The rate at which steel under sea water wastes away over its entire surface is low. Pitting, however, may cause serious trouble in a relatively short period.

If it were not for this pitting tendency of steel, it would be hardly necessary to paint and protect the underwater body of a ship, the Society of Naval Architects and Marine Engineers was told by Paul Ffield, of the Bethlehem Steel Company, Quincy, Mass. The average rate at which the steel is rusted away over its entire surface is less than an eighth of an inch in 20 years, he said.

➤"COASTAL FINISH" *protected the panel on the right from two thousand hours of salt spray action, which caused the corrosion shown on a similar panel, with a standard finish, shown on the left. The new protective coating, developed by Westinghouse, is a sandwich whose middle layer is made up of mica flakes embedded in a syrup-like plastic. It is designed to protect electric transformers from the weather.*

Pitting is a natural tendency of steel, and the rate of attack at the pits is five to ten times greater than the general corrosion attack over the entire exposed surface. The problem of controlling corrosion of the underwater body is largely one of preventing the occurrence of pitting. Regular painting is the usual control.

Paints generally are not completely impervious to sea water under a hydrostatic head, but even if water does get through serious trouble will not occur if the pitting tendency of the

steel is mild. Of real concern to ship operators and builders are the more vigorous causes of pitting.

These include physical conditions which may break down the paint and expose the steel, or an electrochemical effect so powerful that the paint film can not hold it in check.

Pitting corrosion may be due to stray electric currents generated on shore and led to the ship in the water, or to welding during outfitting which may be a source of stray currents. Pitting may also be due to galvanic currents resulting from dissimilar metals in the hull. The control of galvanic corrosion involves avoiding the use of dissimilar metals whenever possible.

Corrosion in Pipelines

➤ THE CONTROL of corrosion in petroleum pipelines, both on the inside and the outside, was a leading subject of discussion at the Los Angeles meeting of the American Petroleum Institute. Unless protective measures are taken pipes carrying crude oil and petroleum products may have a short life.

Internal corrosion is a major problem in producing areas where crude oils with a high content of hydrogen sulfide are prevalent, the Institute was told by J. K. Alfred, Shell Pipe Line Corporation, Colorado City, Texas. One "hot spot" for internal corrosion is the relatively new oil fields in the Permian Basin of West Texas. In this area plastic and cement linings are used to prevent corrosion.

A method of cleaning a pipeline already in use and coating the inside with various vinyl and polyester plastics was described. The method involves the use of two separated rubber plugs which are driven through the pipe by compressed air. They clean the pipe by friction or pressure and coat it by wiping action.

For outside protection, new developments in coatings and electric cathodic methods were discussed by Carlton L. Goodwin, Portland Pipe Line Corp., Portland, Me. Coating alone has a limited effective life, he said. Cathodic protection with an electric current has been effective on bare pipe, but the cost over a long period of time may be excessive.

Effective coatings must retain good electrical resistance underground and have the lowest solubility in crude oil or crude-oil products. He indicated that hot-applied coal-tar enamels are best.

Direct current supply at low voltages is required for the application of cathodic protection. Various methods used to obtain the current were described. The present principal sources are galvanic anodes and rectifiers which convert power-line currents to direct current. The use of galvanic anodes has limited applications. Dry-type rectifiers have proved most successful and dependable.

Magnesium was first produced commercially in the United States in 1915 when the war cut off the former German supply; domestic production was started for the Army for use in tracer bullets, star shells, flares and flashlight powders.

Alloys

by Burton L. Hawk

The dictionary describes an alloy as "a substance composed of two or more metals fused together." This seems to be a logical explanation, so we will accept it.

With the exception of aluminum and copper, most metals are not used in the pure state. For scientists have found that by mixing metals together they can form many "new" metals, some with properties entirely different from the component metals. In this way soft metals can be hardened, brittle metals made tough, corrosion eliminated, melting points lowered or raised, etc.

The various kinds of steel we find in everyday life are alloys of iron with nickel, manganese, tungsten, chormium, vanadium, molybdenum, and other metals. Brass usually contains 30% zinc and 70% copper. Bronze is composed of 5% tin, 15% zinc, 75% copper, and a small quantity of lead. German silver is a mixture of copper, zinc, and silver. Gun-metal is a mixture of copper and tin.

Our silver coins are alloys, containing about 90% silver and 10% copper. Our nickels are only 25% nickel; the rest is copper.

Solder

We will have to confine our home experiments to metals with low melting points, as we assume that not many home labs are equipped to melt such metals as iron, silver, copper, nickel, etc. Metals such as lead, tin, antimony and bismuth form many interesting alloys and an alcohol lamp will supply sufficient heat to melt them.

Perhaps the best known of the low-melting alloys is common solder. It is very easily made and consists of equal quantities of tin and lead.

Place the metals in a crucible and apply sufficient heat to melt them. After they are entirely molten and thoroughly mixed, pour into a mold or any metal container. That's all there is to it. You now have a genuine solder, and it can be used as such.

Wood's Metal

Wood's Metal is an unusual alloy because of its extremely low melting point. It melts at 70 degrees C., which is below the boiling point of water!

Mix together 4 grams of tin, 8 grams of lead, 3 grams of cadmium, and 16 grams of bismuth. Melt in a crucible as before.

Place a small quantity of Wood's Metal in the bottom of a large test tube half filled with water. Heat. If observe closely, you will see the metal melt before the water boils.

Rose's Metal

Another low-melting alloy is Rose's Metal, which melts at 94 degrees. You can prepare it by melting together 10 parts of bismuth, 55 parts of lead, and 5 parts of tin.

These low-melting alloys are quite useful in such devices as electric fuses,

automatic sprinkler systems, automatic fire alarms, safety plugs for boilers, etc. For example, you can appreciate the value of the alloy in a sprinkler system in case of fire. The heat of the flames will easily melt the alloy, thereby releasing large quantities of water which, it is hoped, will extinguish the fire before serious damage occurs.

Pewter

Pewter consists of 8 parts tin and 2 parts of lead. Melt together as above.

Type Metal

Melt together 1 part of tin, 16 parts of lead, and 3 parts of antimony.

Amalgams

When metals are alloyed with mercury, an *amalgam* is formed. They are obtained more easily with the lighter metals.

Sodium Amalgam: Place a small drop of mercury—no larger than a pea—in a mortar. Cut a still smaller piece of clean, dry sodium into very small particles. Add to the mercury and press the two elements together with the pestle. There may be miniature explosions as the elements unite, which are harmless if you use small quantities.

Sodium amalgam is decomposed by water with the evolution of hydrogen.

Ammonium Amalgam: Add a little sodium amalgam to a warm saturated solution of ammonium chloride. The amalgam swells up and forms a porous mass which rapidly decomposes.

Of course, the ammonium radical, NH_4, has never been isolated. The above experiment is quite interesting in that it upholds the theory that if ammonium could be isolated it would have the properties of a metal. Mercury is only miscible with metals.

Aluminum Amalgam: Aluminum amalgam is formed by the action of sodium amalgam upon metallic aluminum.

* * *

Our discussion of alloys must necessarily be limited. There are hundreds of others far too numerous to mention here. Each specialized mechanical or electronic device requires metal parts which must exhibit special properties, Most of these properties can only be obtained through the use of alloys, which are becoming more useful every day.

Discover Rare Mineral Deposit

➤ PREVIOUSLY KNOWN to exist in only two places in the world, a third deposit of the rare mineral *brazilianite* has recently been discovered.

Crystals of the clear, slightly greenish mineral were found in old mine cuts in northeastern Brazil by Dr. Joseph Murdoch, professor of geology at the University of California at Los Angeles.

Before this discovery it was known to exist only in south central Brazil and in New Hampshire. Tiny crystals of the mineral were located in old tantalite and beryl mines in the state of Paraiba, Brazil, which had been active during World War II.

Dr. Murdoch identified the mineral on his return to the United States by its crystalline form, using X-rays.

Fish Farms in Ocean May Feed Hungry World

New Foods From Strange Sources

➤ Piles of sawdust, "fish farms," or unknown creatures which live in a mysterious, echo-bouncing layer in the ocean's depths, all may some day help to feed a hungry world.

Great masses of tiny green algae could be cultivated as a new form of fresh water food. New hybrid plant varieties could greatly boost the vital output of farmers everywhere, from America's corn and wheat belt to Chinese rice paddies or tropical sugar cane plantations.

These are all serious possibilities for increasing the world's future food supply, four scientists reported to the American Philosophical Society in Philadelphia.

Pilot plants are already in operation converting material with little or no food value—sawmill residue, the evil-smelling wastes from wood-pulp mills and cast-off parts of agricultural crops—into digestible sugars, proteins and fats, Dr. Alfred J. Stamm, research chemist of the U. S. Forest Products Laboratory at Madison, Wis., said.

Next to soybean meal, yeast foods made from wood sugar molasses appear to be the cheapest source of proteins in the world. Proteins are among the major foundation stones of human and animal nutrition.

From a ton of wood waste, a ton of sugar-rich molasses can be produced by a Forest Service process developed during World War II. This molasses is palatable to cattle but not to humans. However, the bitterness (much like blackstrap molasses) can be removed by filters or by crystallizing out pure dextrose sugar.

From wood molasses a protein livestock feed high in vitamins can be produced by growing yeasts and molds on the sugar. These yeasts compare favorably in food value with baker's and brewer's yeasts.

Dr. H. A. Spoehr, emeritus chairman of the division of plant biology of the Carnegie Institution of Washington and consultant to the Secretary of State, told of current experiments in growing a form of fresh water algae, the chlorellas, as another source of proteins and fats.

Dr. Merle T. Jenkins, plant scientist for the U. S. Department of Agriculture, said tremendous gains have already been achieved in the yields of farm crops by introduction of hybrid strains.

As examples he cited: Wheat has gone up 20% in 25 years in South Dakota; hybrid corn has boosted acre yields by at least 25%; Japanese rice production has gone up 70% in the past 65 years; Maine is growing 75% more potatoes per acre than 20 years ago; hybrid strains have doubled the yield of sugar cane in Java in 30 years.

It is fish and other foods from the

oceans, however, which may ultimately have to feed expanding populations in areas of the world where there is not enough to eat, according to Dr. L. A. Walford, chief of fishery biology in the U. S. Fish and Wildlife Service.

In the immediate future, cultivation of fish like farm crops, growing them in artificial ponds, in rice paddies, in man-made lakes back of dams or in irrigation ditches can be a most fruitful way of improving the supply of protein foods.

But in the ocean, Dr. Walford reported, there is an unknown thing, still unexploited, still unexplored, which may prove to be an extravagantly large food resource. This is what scientists now call the "deep scattering layer."

During World War II, echo sounding instruments discovered a layer of "something" between the surface and bottom, everywhere in the ocean. Sometimes there was more than one such layer. Scientists who have studied the phenomenon, Dr. Walford said, agree that it is caused by masses of living organisms. But because nets do not exist which can be used at the great depths where the layer occurs, what these organisms are remains unknown.

The least result to be expected from research into the deep scattering layer would be the extension of human knowledge about the earth, Dr. Walford says. The most practical result might be undreamed-of quantities of food.

Blood Iron Changes Day to Night

➤ THE AMOUNT of iron in your blood plasma normally undergoes a regular day and night variation, falling from a high point in the morning to a low one in the evening, scientists at the University of Utah College of Medicine find.

The mean level of iron in blood plasma was about 66% at 5 p.m. and had risen to about 148% at 9 a.m., the scientists found in tests made on seven healthy men. Samples of a couple of teaspoons of blood were taken from these men at intervals of two to four hours throughout the 24 hours. The same sampling and testing was done on another 12 healthy men, starting at 9 a.m. The results were approximately the same, showing that the change through the day was not due to the bleeding.

The daily rhythm of blood plasma iron is apparently related to activity and sleep. Two Scandinavian scientists found that it is shifted in night workers, with the plasma iron levels highest in the afternoon or evening after waking and the lowest in the morning at the end of the night shift of work.

In a group of five normal persons who were leading irregular hours of activity and sleep, there was no definite diurnal cycle, the Utah scientists found. Details of the study were reported by Drs. L. D. Hamilton, C. J. Gubler, G. E. Cartwright and M. M. Wintrobe. So far, they do not know of any explanation for this variation in blood plasma iron level.

New Chemical Studies on Tooth Decay Problems

Chemical Hopes in Dentistry

➤FLUORIDATION of the water supply in Newburgh, N. Y., for the last four years has resulted in a 32.5% drop in the rate of tooth decay among the town's school children, Dr. David B. Ast, director of the bureau of dental health of the New York State Department of Health, reported at the Atlantic City meeting of the American Dental Association.

By contrast, the decay rate in the neighboring town of Kingston has remained the same that it was four years ago.

Newburgh and Kingston are two guinea pig towns which have been putting on a large scale trial of the value of adding sodium fluoride to the water supply for checking tooth decay. The towns are of about the same size and characteristics. At the beginning of the fluoridation trials, the rate of decayed, missing and filled teeth among some 3,200 school children of Newburgh was 20.6 per 100 permanent teeth. The Kingston rate was 20.2.

The difference in decay rates now, Dr. Ast said, cannot be attributed to any differences in the amount of corrective dental service in the two cities.

Fluoridation of water supplies may ultimately reduce the tooth decay problem to the point where the present dental personnel and facilities may be able to control this almost universal disease.

Chemicals Penetrate Teeth

➤FIVE SUBSTANCES that can penetrate the entire structure of the teeth, going through enamel defects and decayed areas and plugging the tiny perforations known as lamellae, were reported by Dr. William Ward Wainwright of the University of Illinois College of Dentistry, Chicago, to the American Dental Association.

The five substances are: calcium chloride, silver nitrate, palladium chloride, sodium iodide and copper nitrate.

The extent to which the tiny perforations are plugged and the nature of the substance doing the plugging seems to have much to do with the incidence of tooth decay.

Certainly the vulnerability of the tooth is increased by the presence of so many permeable tracts, Dr. Wainwright said.

Zinc chloride also could penetrate the lamellae, decayed areas and other defects. Nearly all the lamellae could subsequently be plugged by other substances, however.

Plutonium, atom bomb material, when used in a citrate complex did not penetrate decayed areas and defects. It attached itself to the surface of the enamel.

Discovery of this vulnerability of the tooth, said to be of prime importance in the prevention and treatment of tooth decay, was made by applying

the substances in their radioactive form to teeth that had been extracted. After treatment with the radioactive chemical, the teeth were dissected and the dissected portions applied directly to X-ray film. This gave radioautographs of the teeth for study of their structure.

Metal Teeth in Human Jaws

➤ ARTIFICIAL TOOTH roots of changeless metal can be implanted into human jaws. This technique gives promise of solving one of the most troublesome dental problems.

Attempted for centuries unsuccessfully, the American Dental Association was told this fall that such tooth replacement is now possible.

Cobalt-chromium alloy screws have been implanted experimentally in a dog and in some humans. One is now in its twelfth year in a human jaw, Drs. A. E. and M. S. Strock, Boston dental scientists, reported.

Success in the transplantation of extracted, fully formed, natural teeth has been limited only by the gradual destruction of the tooth roots, according to the Boston dentists. Past attempts to implant metal roots probably failed, they said, because of the reaction of the tissues to the metal. Inert metals which do not react with tissues were unknown at the time of earlier tests.

The dog that had a cobalt-chromium alloy screw implanted in its upper jaw, where a tooth had been missing, did not have any inflammation or abnormality and was able to eat a regular diet. The screw remained firm and immovable without giving any trouble until the dog died more than two years later. Examination showed that there had been no reaction to the screw by the mouth tissues and that the surrounding teeth were normal.

Some of the screws implanted in human jaws became movable. Microscopic examination showed that a membrane had lined the screws and it became obvious that the implants were being rotated on the membrane. It was decided, however, to keep the screws in and some of the implants now in place have been movable for years.

New Carbon Scratches Glass

➤ SCIENTISTS in Britain have developed a new form of carbon hard enough to scratch glass. The new carbon is of primary value in fields of chemistry, electricity and engineering.

"Delanium" is the name given to the new product and it is already in commercial production. Details of the manufacturing process are not revealed, but it is made directly from coal without primary carbonization to the coke, charcoal or carbon powder normally employed in existing techniques.

The new process enables strong impermeable carbon, free from cracks or fissures, to be made in a single stage. The material produced is not only hard enough to scratch glass but tough enough to reduce greatly the danger from breakage in handling fragile shapes, such as long tubes.

Delanium has high thermal conductivity. It is suitable for electrodes.

Wonder Drugs Add More Nourishment to Food

Chemicals Advance Medicine

➤ ONE OF THE two common forms of malaria can now be cured in "practically 100%" of the cases by a new drug, primaquine, Dr. John H. Edgcomb of the University of Chicago announced at the joint meeting in Savannah, Ga., of the American Society of Tropical Medicine and the National Malaria Society.

Ability to prevent relapses in the vivax type of malaria is the important advantage the new drug has over other malaria remedies. When given alone, one out of five patients had a relapse. But when given with quinine, all of 33 patients recovered and had no relapses. Vivax malaria patients ordinarily may have eight to ten attacks, or relapses, even when symptoms of the first attack have been suppressed and the patients have gotten over the attack.

Primaquine is not a "one-shot" cure. Treatment must be given under the supervision of a physician for 14 days.

Weight for weight, primaquine is four times as effective as any antimalaria drug yet tested in the seven million dollar research program begun for the U. S. Government during World War II to find better drugs for treating malaria.

Primaquine is derived from the common corn cob and from coal tar products. It was first synthesized by Drs. Robert C. Elderfield and James D. Head of Columbia University, New York. It was tested first on animals by Dr. L. H. Schmidt of Christ Hospital, Cincinnati.

Trials on human malaria patients were made on volunteers from the convicts at Stateville (Illinois) penitentiary, under supervision of Dr. Alf S. Alving of the University of Chicago. U. S. Army and National Institutes of Health scientists also were on the research team that tested the chemical and established the effective dose for treatment.

New Drug Against Morphine

➤ SUCCESS with a new drug for treating morphine addicts was reported by Drs. Havelock Fraser and Harris Isbell of the U. S. National Institute of Mental Health before the American Society of Pharmacology and Experimental Therapeutics.

The drug may also have great military and civilian value as a pain-reliever in first aid treatment, Drs. Fraser and Isbell pointed out. Its advantage in such cases is that it can be taken by mouth, instead of having to be given by hypodermic injection. It takes effect quickly and the effect lasts from 30 to 48 hours.

The drug is called acetylmethadol and is related to one of the new pain-relieving drugs, methadon.

It seems to be better than other drugs used to help morphine addicts taper off from morphine because its

effect lasts longer and only one dose a day need be given, instead of three or four doses of morphine.

The new drug is addicting, like morphine, so its use must be carefully regulated. Until further trials have been made, it should not be fully accepted for relief of pain, Drs. Fraser and Isbell warned.

A further advantage of acetylmethadol is that it is a synthetic chemical which could prove an excellent substitute for morphine and other opium derivatives for which the United States is dependent on imported supplies.

Dramamine For Ear Trouble

➤ PATIENTS who get dizzy and suffer nausea and vomiting because of inner ear trouble, called labyrinthitis, can be relieved by dramamine, the modern remedy for and preventive of motion sickness.

The results are so good that the drug should be given to all patients with disturbance of balance before resorting to a nerve-cutting operation, alcohol injection or other treatment, in the opinion of Dr. Leslie N. Gay, associate professor of medicine at the Johns Hopkins University School of Medicine.

Discovery of the effectiveness of dramamine in stopping or preventing air, car and seasickness was made by Dr. Gay and Dr. Paul E. Carliner just two years ago. Its effect in inner ear trouble is now reported by Dr. Gay to the Association of Military Surgeons.

The drug was given to six patients within three weeks after the dizziness, nausea and vomiting started. Regardless of the cause of these symptoms, the acute disturbance subsided within one-half hour. In another group of 41 patients who had suffered from the same symptoms for from two months to 25 years all were either completely cured or had only infrequent and minor attacks so long as they continued to take dramamine. But 16 patients with the same symptoms did not get relief with the drug, and five got worse. The failures are unexplained.

Urethane For Bone Cancer

➤ THE CHEMICAL, urethane, is the "treatment of choice" for the bone marrow cancer, multiple myeloma, in the opinion of Drs. Richard A. Haines, William N. Powell and Herbert Bailey, of Temple, Tex.

At a recent meeting of the Southern Medical Association, they reported good results with this chemical in five patients.

One, treated for seven months, has had relief of bone pain and there is evidence that the neck vertebra, broken through the disease, is recalcifying. A second patient, treated with urethane, for over a year has had marked improvement of her anemia as well as relief from the "exquisite" bone pain. She has also returned to some of her household duties.

Besides the improvement in the patients' well being, the Texas physicians reported definite changes in the architecture of the myeloma cell during urethane treatment.

ACTH, famous anti-arthritis pituitary gland hormone, helped one out of three myeloma patients treated.

Stressing the importance of early diagnosis of this cancerous disease, the Texas physicians said that complaint of bone pain was the most frequent early complaint, with anemia and albumin in the urine as the two most common findings from laboratory tests.

Streptomycin Aids in TB

➤ PATIENTS with tuberculosis of the lungs do better and get well faster when given 90-day treatment with stryptomycin along with other treatment such as rest in bed and operations, the U. S. Public Health Service has announced.

The announcement is based on findings reported from 14 groups of scientific TB fighters in various parts of the country, working in collaboration with the Public Health Service.

Careful controls were followed so that the scientists could be sure whether the improvement was due to the drug or to some other factor. Half of a group of 541 patients got streptomycin in the same dosage. All the 541 got the usual forms of treatment.

All patients were examined by X-ray, laboratory tests and otherwise at regular intervals for one year. The ones getting streptomycin soon began to show more improvement than those not getting the drug and continued to be ahead of the non-streptomycin patients all through the year.

Because of the careful controls during the study, there is no question of the validity of the findings, Dr. Robert J. Anderson, chief of the Public Health Service's tuberculosis division, stated.

Details of the study were reported for the group by Dr. Esmond R. Long of Philadelphia and Dr. Shirley H. Ferebee of the Public Health Service.

Tibione Against Leprosy

➤ TIBIONE, a chemical developed in Germany as a tuberculosis remedy, is the most promising new drug for leprosy at present, Dr. Paul T. Erickson of the U. S. Public Health Service reported at the New York Academy of Sciences conference on leprosy.

One of the so-called mold remedies, aureomycin, and paraaminosalicylic acid, called PAS for short, also have shown early good effects on leprosy sores, Dr. Erickson said. Cortisone, the anti-arthritic drug, also may be helpful in some phases of the disease, it appears from limited experience with it.

The most important single advance in treatment of leprosy occurred in 1941. That, Dr. Erickson said, was the introduction of sulfone drugs. The most recent of these is promacetin. These drugs have largely replaced chaulmoogra oil. With the mold remedies and measures for improving the patients's resistance and caring for complications, the sulfones have materially altered the outlook for the leprosy patient and the curability of the disease.

A new method of testing the effectiveness of leprosy drugs in one-twelfth the time previously needed was reported by Drs. E. Grunberg and R. J. Schnitzer of Hoffman-La Roche laboratories, Nutley, N. J. The method makes use of mice as testing animals.

Cream Stops Leech Attacks

➤ LAND-LEECHES, one of the serious plagues of Far Eastern warfare, are

going to find the soldier of the future less tempting prey.

A cheap chemical substance, dimethyl phthalate, made up into a cream with white wax and arachis oil and applied to the shoes and exposed skin of persons venturing into leech country is sufficiently offensive to the leech to make it think twice before attacking its intended victim.

"A light covering of the cream to the footwear and to the skin of the leg as far as the knee sufficed to prevent attacks in country where without such aid bites could have been frequent," reports Dr. F. M. G. Stammers to the journal, *Parasitology*. This British scientist compounded his repellent in London's St. Bartholomew's Hospital and then proved its usefulness in southeastern Ceylon's leech-infested jungles.

The land-leech is a particularly vicious and disabling pest of jungle warfare. It attaches itself to the skin by the hundreds, sucks large quantities of blood and leaves a wound from which blood continues to ooze for a long time after the engorged leech itself has dropped off. These wounds also frequently become the seats of severe infections.

Found in Japan, China, Burma, Malaya, the East Indies, India and Ceylon, in some areas they number as high as 50 to the square yard. Only about an inch long and not thicker than a matchstick when hungry, the leech can worm its soft body through the eyelets of a boot and even between the mesh of a closely woven stocking, so that clothing itself is no protection against it.

Possibly even more effective than dimethyl phthalate, according to Dr. Stammers' findings, is the chemical hydroxy-citronellal, but it is much more expensive than the former chemical and therefore not so practical for general use on large numbers of fighting troops. Both chemicals have the added advantage of being repellent to that other jungle pest: the mosquito.

In the course of his studies on the land-leech Dr. Stammers made some interesting observations on the prey-finding tactics of the parasite. He found that contact with a warm object brought the leech into a sucking position and that it would follow a warm current of air, showing that the temperature of the body is probably one of the signals used by the leech to show it when to attack.

He also found that a 50% reduction in the light shining on the leech brought it to position for an attack, so that it seems likely a person's own shadow is another signal to the leech that a potential victim is approaching.

Skin itself, regardless of its temperature, is attractive to leeches, but Dr. Stammers was not able to extract from skin the specific chemical which attracted the leech.

Itching Relieved by Br and Ca

➤ THE ITCHING, weeping symptoms of some skin diseases can be relieved by a compound of calcium and bromine, Dr. William Parker of St. Louis has reported to the Missouri State Medical Association.

The sedative effect of the bromine ion has long been known. Dr. Parker believes it is soothing in skin trouble

because the skin and the brain and central nervous system are related on an embryologic basis. The calcium in the combination he uses acts as an anti-inflammatory agent by decreasing permeability of the cells. This counteracts or stops the weeping so troublesome in some skin disorders.

Calcium bromido-galactogluconate, with the trade name of Calcibronat, is the compound he uses. It is sold only on prescription.

New Drug For Ringworm

▶ A NEW CHEMICAL remedy which is reported to give quite impressive results in treating ringworm of the scalp in children, athlete's foot and other fungus infections of the skin was announced at a meeting of the New York Academy of Sciences.

The new drug is called "Asterol." It belongs to the class of chemicals called benzothiazoles. The general anti-fungus power of these chemicals led Dr. Norbert Steiger of the Hoffman-La Roche Company, Nutley, N. J., to put together the compound called Asterol for short. Chemically, it is 2-dimethylamino-6-b-diethylaminoethoxy-benzothiazole.

Although possessing quite high anti-fungus activity, the new chemical has a low toxicity and is entirely without skin-irritating effect, tests have shown.

Results of use of Asterol for ringworm of the scalp in children and athlete's foot were reported by Dr. Frederick Reiss of New York University-Bellevue Medical Center, New York, and Dr. Conrad Stritzler an associate of Queens General Hospital, Jamaica, N. Y.

Asterol will not be available for commercial sale until the early spring of 1951 because of the need for additional manufacturing facilities.

The team of Hoffman-La Roche which reported to the membership of the New York Academy of Sciences on the new ringworm and athlete's foot drug treatment consisted of Drs. E. Grunberg, S. Soo-Hoo, E. Titsworth, D. Ressetar and R. J. Schnitzer. Dr. Grunberg described the laboratory studies leading to the discovery of Asterol.

Wonder Drugs Add More Nourishment to Food

▶ A TENTH to a third more nourishment can be obtained from food if one of the new disease-fighting wonder drugs such as penicillin, aureomycin, streptomycin and terramycin antibiotics is taken along with it.

Experiments in animal feeding suggest that humans too can have their growth and health improved by these discoveries, Dr. C. G. King, scientific director of the Nutrition Foundation, reported in summarizing this year's food research.

Yet why these wonder drugs and recently discovered vitamins such as B12 are effective is still a mystery.

Several groups believe that antibiotics can exert a stimulating effect on growth, beyond the effect of all known vitamins. Dr. King said there is widespread agreement that natural protein foods of animal origin such as liver, milk, meat and eggs contain essential nutrients beyond those now identified.

The number of new vitamins yet to be identified cannot be stated with

any sense of finality, but from studies with chickens, turkeys, minks, cats, rats and pigs, research men are convinced that at least two, and perhaps as many as four or five factors remain to be identified.

There is a great deal of interest in discovering the real function of the antibiotics when they stimulate growth. The scientists ask: (1) are they suppressing microorganisms that normally retard the animal's growth as a result of their poisonous end-products? (2) or, are the antibiotics, by suppressing the growth of some organisms, encouraging the growth of others that provide greater quantities of unknown nutrients? (3) or, is the suppression of bacterial growth making available a greater supply of the known vitamins and amino acids that are contained initially in the food?

Whether any of these answers have practical significance lies in the future. Many scientists believe that they will have, Dr. King said, although it is too early to predict how useful the results will be.

When antibiotic supplements are fed to turkeys, chickens and pigs, several groups report gains in weight in the range of 10% to 30% above the expected performance on "good rations." Preliminary tests are also under way with children.

It was disturbing to "pure minded" chemists to discover that feeding two to five percent of just ordinary farm dirt to pigs on test diets caused improvements in growth and health. Again it was surprising when research men testing the vitamin B12 content of good clean suburban New York soil found that after stirring water with the dirt and filtering, the water had a vitamin B12 content comparable to milk.

Anti-Cold Weather Vitamin

➤ One of the new B vitamins, B12 by name, may help our fighting forces withstand long periods in the cold, it appears from studies by B. H. Ershoff and H. B. McWilliams of the Emory W. Thurston Laboratories, Los Angeles. The studies were made in cooperation with the Quartermaster Food and Container Institute for the Armed Forces.

Rats, not men, were the subjects of the experiments. When young rats were kept at room temperature and fed a purified ration, known as diet A, containing the B vitamins in synthetic form only, they grew and developed satisfactorily. But when the animals were kept continuously in a walk-in refrigerator at a temperature just above freezing, their growth and development on this diet were markedly retarded.

Adding dried whole liver, or liver extract, or a water-insoluble liver residue to the diets of the rats in the cold room resulted in a marked increase in weight and development. A supplement of the known B vitamins was equally effective.

The effects of these diet supplements in protecting against the prolonged cold were due, at least in part, to their vitamin B12 content, the scientists think.

Recent Patents in Chemical Fields

Copies of patents may be ordered by number from the U. S. Commissioner of Patents, Washington 25, D. C. Remit 25 cents by coin, money order or Patent Office coupon, but not stamps, for each patent ordered.

➤ A NEW METHOD for artificial production of enzymes, complex organic substances which speed up chemical processes such as fermentation and human digestion, is stated in a patent recently issued.

The enzymes are produced by bacteria grown in tanks or vats on solutions of starches, proteins and bits of broken grain. This system, long sought with little success, is more efficient than producing enzymes on the surface of liquids or on solid nutrients such as yeast.

The inventors of the new process are Carl V. Smythe of Moorestown, N. J., and Billy B. Drake and Clifford E. Neubeck of Philadelphia. Their patent (2,530,210) has been assigned to the Rohm and Haas Co. of Philadelphia, a leading chemical firm.

Better Synthetic Rubber

➤ STRIKING EFFECTS in improving the properties of synthetic rubber is the promise of a new chemical process. In World War II, artificial rubber made from by-products of coal and oil brought headaches to tire manufacturers. The early synthetics cracked easily, built up destructive temperatures at high speeds and became hard and brittle in cold weather.

A chemist named Warren F. Busse of Easton, Pa., has discovered, however, that the addition of compounds known as sulfones makes raw synthetic rubber more easy to process, and the finished synthetic tires more resilient and stretchable. His patent on the process is assigned to the General Aniline & Film Corp.

The twin effects of the chemicals are called tackification and plasticization in the rubber industry. With the new agents described in patent 2,522,776, synthetic rubber becomes more easily molded or extruded into final shapes, and its properties when cured are closer to those of natural rubber. The agents include diaryl sulfones, aryl alkyl sulfones and polysulfones, added in ratios of 2% to 20% by weight of the synthetic rubber.

Salt From Sea Water

➤ A CHEMICAL sleight of hand trick for removing salt and minerals from sea water was awarded patent 2,522,856. The inventor, Arthur M. Buswell of Urbana, Ill., has assigned all rights to the government, as represented by the Secretary of the Navy. The new process produces drinkable water from the ocean. Most likely users: castaways on lifeboats, or life rafts.

When a fresh water cask becomes empty, the inventor says, it may be filled from the sea. About three-quarters of a pound of powdered silver fluosilicate is added per gallon of salt-

water to remove the salt. When the solids have settled, the water is poured off into another cask, and about half an ounce of ordinary lime is added. After this settles, taking with it magnesium and the fluosilicates, the water is ready for drinking.

New Automobile Polish

➤ AUTOMOBILE POLISH containing silica, well-known in sand, and a hydrocarbon-siloxane-water mixture brought patent 2,523,281 to Chester C. Currie, Midland, Mich. The preparation is claimed to supply a superior protective coating to the paint.

Patent rights for the polish and its method of preparation have been assigned to Dow Corning Corporation of Midland. Very finely divided silica is used, and it is incorporated as a cleaner. The amount varies from 2% to 20% by weight. The siloxane used, a silicon hydride with extra oxygen, is a hydrocarbon-soluble organopolysiloxane, from 2% to 6% by weight.

The polishes of this invention are oil-in-water emulsions. They are claimed to clean with a minimum of rubbing. Due to the hydrophobic nature of siloxanes, polished surfaces are repellent to water and they therefore retard corrosion due to salt solutions.

Wax of Carnauba Type

➤ SYNTHETIC WAX, which has properties closely resembling the widely-used imported carnauba wax, is made from domestic paraffin wax and polymerized ethylene by a process for which patent rights have been assigned to Lovell Chemical Company, Watertown, Mass.

Carnauba wax is Brazil wax and is a natural product from the South American pine. It is one of the hardest and most expensive of the commercial waxes and is used in polishes, for waterproofing and as a substitute for beeswax.

Previous mixtures of paraffin wax and polyethylene exhibit incompatibility when cooled to room temperatures. In this process the inventors have found that by maintaining paraffin wax at a molten temperature of approximately 320 degrees Fahrenheit and by adding to this molten fluid polymerized ethylene they obtain a solid solution of complete compatibility. Inventors are Stanley P. Lovell, Newtonville, and Harry H. Straw, Arlington, Mass.

Constant Height Balloon

➤ AN UNATTACHED, or free-flying, balloon that will ascend to a certain altitude and float about, remaining constantly at that height above the earth, was awarded a patent by the government this week.

A free-flying, constant-level balloon of this type has many military applications and also can be used to carry self-recording instruments used in studying weather conditions aloft. Captive balloons are not wholly satisfactory, particularly for studying the motions of air masses. The ordinary free-flying balloon now used does not stay at a constant altitude. It continues to ascend until it bursts.

This constant-level balloon contains a gas chamber within a much larger gas chamber. The outer one, filled with hydrogen or helium, is made of elastic material and is free to expand in the decreasing atmospheric pressures encountered in the ascent.

The inner gas chamber, which may be filled with air, is made of a non-elastic material. By a valve arrangement, controlled by the pressure changes in the non-elastic envelope, gas from both chambers can escape into the atmosphere to maintain conditions that assure constant level.

The inventor is Langley W. Isom, Belmont, Mass. He received patent 2,524,567. Rights have been assigned to Dewey and Almy Chemical Company, Cambridge, Mass.

Sensitive Heat-Detector

➤ An improved sensitive heat-detecting instrument, of the type known as a bolometer, brought Victor S. Rutherford, East Cleveland, and James F. English, Jr., Lakewood, Ohio, patent 2,524,478. Bailey Meter Company, Cleveland, has acquired the patent by assignment. The instrument is of the electrical resistance type.

Bolometers are sensitive instruments that can pick up minute heat radiations from distant objects. They were employed during the war to detect invisible airplanes in the air by the heat emitted by the plane and its engines. They also have been used to detect an invisible prowler in the dark.

A particularly important feature of this new bolometer is its sensitivity to not one but all wavelengths of thermal radiation. Another feature is its ability to produce an electrical effect representative of the energy level of the received radiation with greater efficiency than older devices.

Cheaper Ammonium Sulfate

➤ Cheaper fertilizer to supply nitrogen for crops may result from a new and novel method of making ammonium sulfate, which is obtained in a substantially dry and free-flowing form. It is based, like other processes for making this highly important chemical, upon a reaction of ammonia with sulfuric acid.

The new process consists of spraying sulfuric acid of from 80% to 100% concentration into an atmosphere of ammonia containing more ammonia than actually needed in the reaction. The ammonium sulfate as it forms is sprayed with a liquid coolant having a boiling point not greater than 240 degrees Fahrenheit. During the process a temperature between 250 and 300 degrees Fahrenheit is maintained in the reaction chamber.

Scientists responsible for this new process are Harold D. Chapman and William I. Denton, Woodbury, and Richard B. Bishop, Haddonfield, N. J. Rights to the patent, No. 2,524,341, have been assigned to Socony-Vacuum Oil Company, New York City.

Chemicals With Pepper's Bite

➤ Some peppery chemicals have been made in the Quartermaster General Laboratories located in Philadelphia. They are known chemically as piperazonium salts. They dissolve in water and their pungent taste is like that of the piperine of black pepper. Details of the production of these snappy chemicals were reported by Torsten Hasselstrom, Norene E. Kennedy, Clifford E. Balmer and Harold W. Coles.

Proudly Presented

➤ BARIUM FRUCTOSE-6-phosphate, dipotassium glucose-1-phosphate, and barium phosphoglyceric acid, three phosphorylated compounds vitally important in studies of fermentation or enzyme reactions, are now available from Schwarz Laboratories.

Fructose-6-phosphate, the Neuberg ester, is one of the sugar phosphates occurring during fermentation. It is a useful substrate in studies of sugar metabolism and in other biochemical studies. Fructose-6-phosphate is a reducing compound with a copper-reducing value about three-fourths that of fructose. In the presence of methylene blue, fructose-6-phosphate is oxidized by dehydrogenase of liver and, for example, coenzyme I, also available from Schwarz Laboratories.

Glucose-1-phosphate, originally called Cori ester after its discoverers, is an intermediate in the formation of glycogen and starch from sugar. Available as the dipotassium salt, in a pure crystalline form, it is useful in studies of carbohydrate metabolism, since it is the first compound appearing when cells and tissues utilize glycogen as a source of energy.

Phosphoglyceric acid occurs about midway in the transition of sugar to ethyl alcohol. This crystalline, levorotatory compound is a useful substrate in studies of the enzyme reactions taking place in fermentation and glycolysis. Yeast and muscle enzyme ferment phosphoglyceric acid, indicating that it is formed in the normal metabolism of sugar. Phosphoglycerates counteract the inhibiting effect of dl-glyceraldehyde on the anaerobic glycolysis and respiration of tumor, testis, and kidney tissue.

Further information on these products and their use in fundamental fermentation studies may be obtained by addressing Schwarz Laboratories, Inc., 202 East 44th Street, New York 17, N. Y.

➤ TRIMETHYLHEXANOL, a nine-carbon alcohol described as a colorless, mobile liquid of mild odor, is now manufactured by Du Pont as a single substance of high purity. It undergoes many chemical reactions, of which esterification is regarded as the most promising for production of plasticizers, synthetic lubricants and improvers of viscosity index. It has a boiling point of 190° C., and is not soluble in water. Further information on applications may be obtained from the Ammonia Department of E. I. du Pont de Nemours & Co., Wilmington, Del.

➤ TWO PLASTIC PRODUCTS, one polymerizing at room temperature and the other at temperatures of 250° to 275° F., are announced by Ernest F. Boruski, Jr., manufacturer's representative, 505 Firth Ave., New York 17, N. Y. Their use for making flexible molds for reproducing delicate models which cannot tolerate heat is suggested.

➤ CASHEW NUT SHELL oil is available in hydrogenated form as a low-melting, waxy solid consisting of a mixture of meta-substituted phenols. Further information and generous samples are promised by the Irvington Varnish and Insulator Co., Irvington 11, N. J.

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